UNITED STATES
COAST AND GEODETIC SURVEY

J. E. HILGARD
SUPERINTENDENT

METHODS AND RESULTS

DETERMINATIONS OF GRAVITY

AT STATIONS IN PENNSYLVANIA

1879—1880

APPENDIX No. 19—REPORT FOR 1883

WASHINGTON
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DETERMINATIONS OF GRAVITY AT ALLEGHENY, EBENSBURGH, AND YORK, PA., IN 1879 AND 1880.

By CHARLES S. PEIRCE, Assistant.

I.—GRAVITY AT THE ALLEGHENY OBSERVATORY.

The Allegheny Observatory is situated in—

Latitude 40° 27′ 41″.6 north,

Longitude $5^h\ 20^m\ 2^s.93$ west of Greenwich.

It stands 1,140 feet (=348 meters) above the mean sea-level.* From a few yards in front of the observatory the descent is very sharp into the valley of the Ohio, and as this has been formed by erosion, it must be supposed to diminish the acceleration of gravity, perhaps by the one hundred thousandth part. Unfortunately the necessary calculation, which a topographical sketch would enable us to perform at once, remains impossible for the present.

The operations were conducted nearly as described in my "Measurements of Gravity at Initial Stations." The Repsold reversible pendulum was oscillated in vacuo on the Geneva support, in the cellar of the observatory, the feet of the support resting on iron bars laid upon other bars let into the great pier of the equatorial at one end and into a stone wall at the other.

Measures of the length of the pendulum were commenced 1879, January 2; but owing to the difficulty of maintaining a tolerably constant temperature in any part of the observatory that was otherwise suited for a comparing-room, no valuable results were obtained before January 18; and even after that date, it was found necessary to reject the work of several days, owing to bad conditions. The first series of measures of length was completed February 1. Four swingings of the pendulum were made on February 6 and 7 with heavy end up, and two swingings on February 8and 9 with heavy end down. On February 10, the position of the center of mass was determined and the knives were interchanged. Two days were then lost in trying to make the vacuum chamber stanch; after which two swingings were made with heavy end down, February 13 and 14, and four with heavy end up February 15, 16, and 17. On February 18 and 20, the flexure of the apparatus was measured, and these measures were supplemented by others on March 4. From February 22 to March 2, the pendulum was measured. The thermometers were compared from 1878, December 19 to 31, and again 1879, March 3.

The following table gives a synopsis of the results of the swingings, the period being corrected for the rate of the clock and for arc of oscillation, and being reduced to 15° C. and to a pressure of one million absolute C. G. S. units. The approximate pressure in millimeters of mercury and the approximate temperature centigrade are also shown. It is unnecessary to say that the air-pump was never brought into action during any swinging.

The agreement of the resulting periods is, as far as it goes, favorable to the plan of swinging *in vacuo*. It will be noticed that the oscillations were continued down to a small amplitude, but there seems to have been no increased error upon this account. Following the synopsis will be found a table of the errors of the partial swingings formed by intermediate transits, as shown on pages 502–503. The errors given are differences from the following periods, deduced from the final results:

T_d (knife 1)=$1^s.0064527$	T_u (knife 2)=$1^s.0066434$
T_d (knife 2)=1 .0064463	T_u (knife 1)=1 .0066370

* The latitude and longitude here given have been extracted from the American Ephemeris. The elevation is from data furnished to Professor Langley by the Allegheny City surveyor and by the engineer of the Pennsylvania Railway.

The errors are multiplied by the square roots of the number of oscillations, and the products are shown to be constant in the mean. It is also noticeable that this constant has the same value whichever end is up. Several obvious inferences might be made. In particular, it will be seen that the error of the result depends only on the total number of oscillations, no matter how they may be separated by intervals of rest.

HEAVY END UP. KNIFE No. 2.

Date.	Temperature.		Pressure.		Half arc in terms of radius.		Number of oscillations.	Corrected period.
	Maximum.	Minimum.	Beginning.	End.	Beginning.	End.		
1879.	°	°	*mm.*	*mm.*				*s.*
February 6.....	0.3	0.3	23	25	.023	.003	20,891	1.0066466
6.....	0.8	0.4	29	36	.030	.003	21,406	1.0066428
7.....	0.5	0.3	43	46	.030	.002	21,420	1.0066399
7.....	0.7	0.4	20	20	.034	.005	19,742	1.0066430
							83,459	1.0066431

HEAVY END DOWN. KNIFE No. 1.

February 8.....	0.7	0.1	13	14	.033	.002	74,805	1.0064533
9.....	0.3	—0.1	14	15	.035	.002	75,680	1.0064515
							150,485	1.0064524

HEAVY END DOWN. KNIFE No. 2.

February 13....	1.5	—0.5	17	40	.033	.002	61,844	1.0064471
14....	—0.3	—1.3	18	40	.035	.002	67,626	1.0064470
							129,470	1.0064470

HEAVY END UP. KNIFE No. 1.

February 15....	—0.6	—1.1	17	29	.034	.004	19,822	1.0066370
16....	—1.0	—1.2	17	35	.034	.004	20,766	1.0066337
16....	—0.9	—1.1	15	35	.034	.003	22,588	1.0066380
17....	—0.7	—0.9	21	37	.036	.003	20,848	1.0066411
							84,024	1.0066375

Errors of partial and total swingings.

Heavy end up.						Heavy end down.					
Knife No. 2.			Knife No. 1.			Knife No. 2.			Knife No. 1.		
Partial swingings.			Partial swingings.			Partial swingings.			Partial swingings.		
Error in 7ᵇ place.	Sq. root. No. oscill.	Product in 5ᵇ place.	Error in 7ᵇ place.	Sq. root. No. oscill.	Product in 5ᵇ place.	Error in 7ᵇ place.	Sq. root. No. oscill.	Product in 5ᵇ place.	Error in 7ᵇ place.	Sq. root. No. oscill.	Product in 5ᵇ place.
+43	57	25	+ 6	70	4	− 4	77	3	+80	78	63
+ 2	77	2	− 1	87	1	+ 48	83	40	+19	178	34
+24	83	20	− 3	86	3	+ 29	87	25	−27	94	25
+74	69	51				−180	31	56	− 9	88	8
			−66	85	56	+ 43	73	31	−35	87	30
+ 3	94	3	−13	79	10	+ 10	198	20			
−22	79	17	−18	85	15	− 61	93	57	−39	82	32
− 3	80	2							+38	88	33
			−15	82	12	+ 1	78	1	+53	83	44
−66	63	42	+28	92	26	+ 35	84	29	− 6	192	11
+30	59	18	+13	83	11	− 12	88	11	−23	95	22
−76	82	62				− 9	81	7	Mean of products.		29
−16	85	15	−28	81	23	− 11	178	20			
			+49	85	41	− 43	99	43			
+36	87	31	+99	83	82	− 19	82	16			
− 7	87	6	Mean of products.		26	Mean of products.		26			
−58	73	42									
Mean of products.		24									
Whole swingings.			Whole swingings.			Whole swingings.			Whole swingings.		
+32	145	46	00	141	00	+ 6	273	16	+ 8	249	20
− 6	146	8	−33	144	48	− 12	275	33	+ 7	260	18
−35	146	51	+10	150	15	Mean of products.		24	Mean of products.		19
− 4	140	6	+41	144	59						
Mean of products.		28	Mean of products.		30						

Time was observed by Mr. F. W. Very, Professor Langley's assistant, with the instruments of the observatory, a fine 8-inch transit and the sidereal clock (Frodsham 1358). The chronometer, Negus 1589, was used for the pendulum observations; and this chronometer as well as two others (Hutton 202 and Bond 380) were compared upon the chronograph with the clock three times a day, between 3 and 4 o'clock in the afternoon and between 9 and 10 morning and evening.

The corrections to the chronometer used were obtained by assuming that between certain dates certain time-pieces moved with absolute uniformity, the changes of rate being supposed to be sudden. This is the same method of reduction used in my previous work, and appears to me most consonant with observed facts in regard to the running of timepieces. The standards used were as follows:

Date.	Sidereal time.	Timepiece assumed uniform from each time to next.
	h. m.	
February 4	6 18	Frodsham, 1358.
6	5 25	Do.
9	6 47	Do.
13	7 14	Hutton, 202.
15	8 02	Frodsham, 1358.
21	7 12	

The results of the comparisons of the length of the pendulum with the pendulum meter were as follows:

MEASURES OF LENGTH.

FIRST SERIES.

Date. 1879.	Pend. —standard. μ
January 18	+26.1
January 21	+24.6
January 22	+26.4
January 23	+20.3
Mean	

SECOND SERIES.

	μ
January 25	+22.8
January 29	+25.5
January 31	+23.2
February 1	+18.6
Mean	+22.5

THIRD SERIES.

February 22	+11.3
February 23	+10.2
February 24	+ 9.9
February 25	+ 9.1
February 26	+12.1
March 1	+15.0
March 2	+11.6
Mean	+11.3

These results have to be diminished by $200^{\mu}.4$, because they are referred to the mean of the three lines $999^{mm}.7$, $999^{mm}.8$, $999^{mm}.9$ of the standard instead of to the meter. They have then to be increased by $261^{\mu}.1$ in order to be referred to the meter adopted in my "Measurements of Gravity at Initial Stations." It follows that the length of the pendulum in terms of the meter adopted in my previous work (which is now known to be erroneous, but which is for the present adhered to, in order to avoid confusion) was

	m.
Before the interchange of knives	1.0000853
After the interchange of knives	1.0000732

The difference of the distances of the center of mass from the two knife-edges was found to be $0^{m}.39303$, to which the correction, +.00014, has to be applied.*

The experiments to determine the flexure of the support have already been published in the Coast Survey Report for 1881, pp. 375–377. The mean of the measurements of two observers shows that the flexure at the middle of the knife-edge, under a horizontal force equal to the weight of the pendulum, was $38^{\mu}.8$.

We now proceed to calculate [T^2 Rev.] and [T^2 Inv.], as in the paper above referred to. Only, it is to be remarked that, in consequence of what is said on page 72 of that paper (page 271 of the Coast Survey Report for 1876), one-seventh of the viscosity effect has to be subtracted in order to eliminate the effect of the bells; that is to say, T_d has to be diminished by 66×10^{-7} and T_u by 151×10^{-7}. The values have to be separately calculated for the experiments made before and after the interchange of the knives.

Before the interchange of knives.

	s.		*s.*
T_d	1.0064524	T_u	1.0066431
Bells and cylinder	—145	Bells and cylinder	—321
	1.0064379		1.0066110
T_d^2	1.0129172	T_u^2	1.0132657
Flexure	—270	Flexure	—118
Stretching			+ 10
Corrected T_d^2	1.0128902	Corrected T_u^2	1.0132549

* See *Measurements at Initial Stations*, p. 114 (Coast Survey Report for 1876, p. 313), where the correction is, however, applied with the wrong sign.

After the interchange of knives.

T_d	1ˢ.0064470	T_u	1.0066375
Bells and cylinder	—145	Bells and cylinder	—321
	1.0064325		1.0066054
T_d^2	1.0129064	T_u^2	1.0032545
Flexure	—270	Flexure	—118
Stretching			+ 10
Corrected T_d^2	1.0128794	Corrected T_u^2	1.0132437

	Before interchange.	After interchange.
	s.	*s.*
Corrected T_d^2	1.0128902	1.0128794
Corrected T_u^2	1.0132549	1.0132437
$\frac{1}{2}(T_d^2+T_u^2)$	1.0130725	1.0130615
$\frac{1}{2}(T_d^2-T_u^2)$	—1824	—1822
$\frac{h_d-h_u}{h_d+h_u}\frac{1}{2}(T_d^2-T_u^2)$	— 717	— 716
$\frac{h_d+h_u}{h_d-h_u}\frac{1}{2}(T_d^2-T_u^2)$	—4638	—4633
[T^s Inv.]	1.0130009	1.0129899
[T^s Rev.]	1.0126087	1.0125982
[T^s Inv.]—[T^s Rev.]	3922	3917

The two values of [T^s Rev.] combined with the two values of the length, give for the seconds' pendulum at Allegheny:

	m.
Before the interchange of knives	0.9930479
After the interchange of knives	0.9930461
Mean	0.9930470

This is the final result from this station alone. But the correction for the erroneous length of the meter, as provisionally stated in the Coast Survey Report for 1881, page 463, is -162×10^{-7}, giving

m.
0.9930308;

and this may further be modified by the effect of measurements at other stations, and comparisons of [T^s Inv.]. There is, however, reason to believe that such modification would be, in this case, insignificant.

Applying the correction for elevation, without continental attraction, diminished by one-tenth part, and the correction for latitude, as in my paper (C. S. Report, 1881, p. 445), we have

	m.
Seconds' pendulum at Allegheny	0.9930308
Elevation	+979
Latitude	—21903
Reduced to equator and sea-level	0.9909384

This would be increased if the effect of the valley were taken into account. A topographical sketch of this vicinity is the most pressing need of the work at this time.

The details of the work at the Allegheny Observatory are given in the tables appended to the edition of this Appendix, which has been published separately.

II.—DETERMINATION OF GRAVITY AT EBENSBURGH.

Ebensburgh is the chief (though not the principal) town of Cambria County, Pennsylvania, in the Allegheny Mountains. The observations were made in the house and grounds of Mrs. Frances S. McDonald, on Centre street. The place is shown on the county map by Beers (1867),

where the house has marked under it "J. M. McDonald." It is at the southeast corner of the street next south from Highland street. The transit pier is 23½ meters south of the northern boundary and 28½ meters east of the western boundary of the lot. The pendulum was observed in the cellar of the house.

The latitude of the station, +40° 27′, was determined by Mr. Marcus Baker by sextant observations upon the Sun, Jupiter, and Polaris. The longitude was determined by telegraphic exchanges with the Allegheny Observatory, the observers being Mr. F. W. Very and Mr. H. Farquhar with the result:

	h.	*m.*	*s.*
Ebensburgh east of Allegheny,	0	5	9.2
Ebensburgh west of Greenwich,	5	14	53.7

The elevation of the station has been ascertained from that of the railway at the station, as communicated by the engineer of the Pennsylvania Railway. The pendulum station was connected with the railway by a line of levels. The elevation so found is 2,137 feet (=651 meters).

It was intended to conduct the operations as at Allegheny; but various difficulties compelled me to support the pendulum on the Repsold tripod, as at my European stations. The brass footrests were placed directly upon the hard clay floor of the cellar. The old knives which had been used in Europe and in the stations at Hoboken and at Allegheny were replaced by new ones, made by Messrs. Darling, Brown, and Sharpe, of Providence. The amplitude of oscillation was measured on a fine arc by Messrs. Stackpole & Brothers, which is divided into thousandths of the radius. The arc and transits were observed with a reading telescope carrying an objective corrected for use at a short distance by Byrne, of New York. The same eye-piece was constantly used. The telescope was placed at a distance of two meters from the pendulum; and no screen was interposed between them.

The general order of the pendulum experiments was as follows:

1879.

August 14–21.—Measurements of length.
September 5.—Swinging, heavy end down; knife, 3–4.
Swinging, heavy end up; knife, 7–8.
September 6.—Swinging, heavy end up; knife, 7–8.
Swinging, heavy end down; knife, 3–4.
Center of mass determined.
Interchange of knives.
Center of mass determined.
September 7.—Swinging, heavy end down; knife, 7–8.
Swinging, heavy end up; knife, 3–4.
September 8.—Swinging, heavy end up; knife, 3–4.
Swinging, heavy end down; knife, 7–8.
September 10–13.—Measurements of length.
September 14.—Swinging, heavy end down; knife, 7–8.
Swinging, heavy end up; knife, 3–4.
September 15.—Swinging, heavy end up; knife, 3–4.
Swinging, heavy end down; knife, 7–8.
September 16.—Determination of center of mass.
Interchange of knives.
Determination of center of mass.
Swinging, heavy end down; knife, 3–7.
Swinging, heavy end up; knife, 7–8.
September 17.—Swinging, heavy end up; knife, 7–8.
Swinging, heavy end down; knife, 3–4.
September 18–25.—Measurements of length.

A synopsis of the periods of oscillation at Ebensburgh is given below. These periods have received not only the reductions for arc, rate, temperature, and pressure, but also peculiar *à priori*

corrections for flexure of the support, difference of knives, and injury to the pendulum. These I proceed to explain:

After half the swingings had been made, the pendulum was measured. In adjusting the microscopes a plumb-line was used; and to attach this it was necessary to remove the two forward nuts which bind the head of the support to the legs of the tripod. These were afterward replaced for the rest of the swingings, but instead of being tightened by a wrench they were only tightened by hand. This negligence was only discovered after all the swingings were completed, and it was then too late to repeat them. Elaborate experiments (see Coast Survey Report for 1881, Appendix 14) were accordingly instituted to determine the flexure of the support when the nuts in question were hand-tightened and when they were wrenched. The values given on page 388 of the Report have been used in the reductions, and the periods have accordingly received the following corrections:

	Heavy end down.	Heavy end up.
First four days	−.0000832	−.0000362
Last four days	−.0000895	−.0000390

The knives used at Ebensburgh and York, which are marked 3–4 and 7–8, have, at my request, been micrometrically examined by Assistant Edwin Smith, to determine the distance of the edges from the plane of the bearings. He obtained the following results:

Knife 3—4. At end marked 3, 122 . At end marked 4, 125$^{\mu}$.

Knife 7—8. At end marked 7, 168 . At end marked 8, 170 .

On September 11 the record notes that a small spring belonging to the attachment of the knife at the *light* end of the pendulum was found to be broken. In consequence of this the pendulum must have lost mass, and the center of mass should have been removed toward the heavy end. In examining the measures of the position of the center of mass, we find that at York, the station occupied after Ebensburgh, the center of mass was distant $0^{m}.30333$ from the knife-edge at the heavy end. In fact, using an empirical correction for the relative position of the knives, the individual results (16 in number) show a probable error of $\pm.000013$. At Ebensburgh, measures were made on September 6 and September 16. The four individual measures on September 16, with the correction for position of knives, give for h_u

m.
0.30330
0.30332
0.30330
0.30339

Rejecting the last observation, in which there seems to have been an erroneous reading, the others give $0^{m}.30331$, not differing sensibly from the value at York. The measures of the 6th give

m.
0.30324
0.30330
0.30327
0.30328

These show a value sensibly smaller than that of the 16th. The difference is such as would be produced by the loss of something less than a gramme at the *heavy* end. The distance between the knife-edges not having changed, no other changes can affect the result from the pendulum—considered as reversible—although the accident, whatever it was, must spoil the agreement of the different days. Although it does not affect the final result, I have, in the calculation, supposed that a gramme was lost at the *heavy* end, 2 centimeters beyond the knife-edge. The result of placing a small mass, m, on the pendulum at a distance of x meters and $l+x$ meters from the two knife-edges is easily found to be to increase the periods of oscillation by

$$\triangle T_d = T_d \frac{m}{M} \frac{x(l+x)}{2 h_d l}$$

$$\triangle T_u = T_u \frac{m}{M} \frac{x(l+x)}{2 h_u l}$$

Where M is the mass of the reversible pendulum, l the distance between the edges, h_d and h_u the distances of the center of mass from the two edges, and T_d and T_u the periods. In the present case we have $m=-1$, M=6308, $x=+.02$, $l=1$, $h_d=0.7$, $h_u=0.3$, $T_d=T_u=1$. We have, therefore,

$$\triangle T_d = -.0000023$$
$$\triangle T_u = -.0000054$$

and *these corrections have been applied to the first four days*, so as to reduce the pendulum to its state at the end of the work at this station.

Synopsis of periods of oscillation.

1879.	HEAVY END DOWN. Knife, 7–8.	HEAVY END UP. Knife, 3–4.
	s.	s.
September 5	1.0064424	1.0065264
September 6	1.0064377	1.0065054
	Knife, 3–4.	Knife, 7–8.
September 7	1.0064482	1.0065122
September 8	1.0064400	1.0064296
September 14	1.0064377	1.0065024
September 15	1.0064389	1.0064789
	Knife, 7–8.	Knife, 3–4.
September 16	1.0064401	1.0065157
September 17	1.0064385	1.0064895

The period for September 8, with heavy end up, is obviously affected by an abnormal error. The Paris, Berlin, Kew, Hoboken observations show that the probable error of a period from a single swinging with heavy end up is $\pm 0^s.000006$. The period for September 8 differs from the mean of the others by $0^s.000077$, having thus an error about thirteen times the probable error, an event which would occur by chance only once in a million × million × million times. We may, therefore, safely say that on that day there was some extraordinary force tending to restore the pendulum to the vertical. The records of observations of arc show the following times of decrement on different days:

	From .0400 to .0180.	From .0180 to .0080.
	m.	m.
September 5	20.9	28.6
September 6	20.7	28.8
September 7	21.1	28.4
September 8	17.1	21.3
September 14	21.3	28.6
September 15	17.2	26.8
September 16	21.1	28.8
September 17	19.7	27.0
Mean 5, 6, 7, 14, 16	21.0	28.3

It thus appears that on the 8th there was some extraordinary force tending to bring the pendulum to rest. These facts suggest that a spider's line might on that day have connected the pendulum with the stand, and this supposition is somewhat strengthened by finding that on that day the operations commenced with oscillating the pendulum with heavy end up in the position in which it had been left the night before. On the 15th and 17th, also, the arc descended rapidly, the periods are very short, and the pendulum had been left over night with the heavy end up ready for the oscillations which were begun in this position in the morning. If there were spider lines on these mornings, we should expect the disturbing influence to decrease as the arc descended. Whether this is so in regard to the effect on the decrement on the 8th it is difficult to say, but it certainly is so on the 15th and 17th. Transits were observed shortly after the arcs reached .0400,

.0180, and .0080, so that there are two intervals from which periods can be deduced. These periods, corrected as in the synopsis, are

	HEAVY END UP.	
	First interval.	Second interval.
	s.	s.
September 8	1.0064130	1.0064385
September 15	1.0064423	1.0064931
September 17	1.0064683	1.0065020

These numbers certainly confirm the hypothesis of spider-lines; and I shall consequently entirely reject the work with heavy end up on September 8 and the first intervals on September 15 and 17. With these rejections the mean periods for pairs of days in which the circumstances were the same, except the time of beginning (for on alternate days the position of the pendulum at the first swinging alternated), are as follows:

Heavy end down.	Heavy end up.
s.	s.
1. 0064400	1. 0065159
1. 0064441	1. 0065122
1. 0064383	1. 0064978
1. 0064393	1. 0065088
Means, 1. 0064404	1. 0065087

The time observations at Ebensburg were made with transit No. 5 carrying a reticule divided on glass by Prof. W. A. Rogers. The equatorial intervals of the five middle wires are sensibly equal to $2^s.583$. The pivot inequality was determined by Mr. Marcus Baker to be $+0^s.030$ with illumination west. Both lamps were in place during the whole of the observations, which were made by Mr. Henry Farquhar. The reductions were made by least squares, using Mr. Schott's weights of 1872. Separate azimuths were assumed for the two positions. The chronograph was a fillet-reed instrument, by Breguet. The battery consisted of two sulphate of copper gravity cells.

Chronometer Negus 1589 was always used for the star and pendulum observations, as this was undoubtedly our best chronometer. Chronometers Frodsham 2490, Hutton 202, and Bond 380, were compared with Negus twice daily. The two former break every second omitting the 0; the two latter break every even second, and also at 59^s. Frodsham and Bond were wound at 8.30 a. m.; Negus and Hutton at 8.30 p. m. at first, afterward at 9 p. m. until September 23, and after that at 6 p. m. Chronometers Negus, Frodsham, and Bond were in their external cases. All four rested firmly on sand heaped on the cellar floor about 15 cm. from an inner foundation wall and 30 cm. from one another. They were placed in this order: Negus, Hutton, Frodsham, Bond. The boxes of Hutton, Frodsham, and Bond were never opened except to wind them. The daily range of temperature in the cellar averaged less than 5 °C. The chronometers were compared with the clock of the Allegheny Observatory twice daily.

The measurements of length before the first interchange of knives were as follows:

	Pend.—standard.
	μ.
August 18	+16.4
19	+16.3
19	+16.9
20	+16.9
20	+21.5
21	+17.5
Mean	+17.6

But these measures are uncorrected for the difference of temperature between the pendulum and the standard; and in point of fact the former carried no thermometer. We may assume that the result should have a correction of $+2^{\mu}.4$ on this account, because this is the mean value of the correction in the following series. With this correction the mean result is that the pendulum was longer than the standard by $20^{\mu}.0$.

After the first interchange the results were these:

	Pend.—standard.
September 10	+19. 4
11	+18. 6
12	+18. 4
13	+19. 5
Mean	+19. 0

After the second interchange the results were as follows:

	Pend. standard.
	μ
September 23	+19.5
23	+20.3
24	+21.5
24	+21.3
25	+17.0
25	+17.7
Mean	+19.5

We conclude that the pendulum preserved the same length at all times, and was 19$^{\mu}$.5 longer than the standard. The latter at 15° C. is 261$^{\mu}$.1 longer than the meter assumed in the "Measurements of Gravity at Initial Stations"; so that in terms of that meter the length of the pendulum at 15° C. was

$1^{m}.0002806.$

The difference in the distances of the center of mass from the two knife-edges was found to be in one position

$0^{m}.39351$

and in the other

$0^{m}.39352.$

To these values must be applied a small correction, $+.14^{mm}$, which in the "Measurements of Gravity at Initial Stations" is correctly given, but is applied with the wrong sign.

The following is the calculation of the length of the seconds pendulum from the first four and last four days' oscillations at Ebensburgh:

	First days.	Last days.
	s	s
T_d	1.0064420	1.0064388
T_u	1.0065140	1.0065033
T_d^2	1.0129255	1.0129191
T_u^2	1.0130704	1.0130489
Corr. stretching	1.0130714	1.0130499
$\frac{1}{2}(T_d^2+T_u^2)$	1.0129985	1.0129845
$\frac{1}{2}(T_d^2-T_u^2)$	—730	—654
$(h_d+h_u):(h_d-h_u)$	2.54045	2.54097
[T^2 Rev.]	1.0128131	1.0128187
Same in mean time	1.0072880	1.0072936
Length pend	1.0002806	1.0002806
Sec. pend	0.9930432	0.9930379

Seconds pendulum at Ebensburgh = $0^{m}.9930406$.

This is expressed in terms of the erroneous meter having the provisional correction -162×10^{-7}. Applying as for Allegheny the corrections for elevation and latitude, we have

Seconds pendulum at Ebensburgh....	0.9930244
Elevation	+1827
Latitude	−21399
Corrected to equator and sea-level....	0.9910672

In the tables appended to the edition of this Appendix which has been published separately are given the details of the work at Ebensburgh.

III.—DETERMINATION OF GRAVITY AT YORK.

York, Pa., is situated east of the Alleghanies in a comparatively plain country. The pendulum was oscillated in the cellar of the factory of Mr. A. B. Farquhar, near the railway station, on Duke street. The transit was about a hundred yards to the east of the factory, on land belonging to Messrs. Billmeyer and Small, in Gay alley. The co-ordinates of the station are:

Latitude, 39° 58′ north.

Longitude, $5^h\ 05^m\ 54^s$ west of Greenwich.

Elevation, 122 meters (373 feet).

The work at this station was conducted by Mr. Henry Farquhar, under my supervision. The pendulum observations were partly made according to a method of eye-and-ear coincidences invented by Mr. Farquhar. For the purpose of studying the effects of flexure, the Repsold reversible pendulum was oscillated on various supports, viz: 1st, on the Repsold tripod; 2d, on a solid support formed by bolting the head of the Repsold tripod to an oaken plank 2 inches thick; 3d, on the Geneva support and tripod, with the bells off and with the bells on (this to ascertain the effect of the bells); 4th, on the Repsold tripod mounted on a wooden support; 5th, on the Repsold tripod resting on pieces of India rubber.

Experiments were also made at this station upon the effect of substituting rollers for the knives as the bearings of the pendulum. The rollers were steel cylinders of 5^{mm} diameter, backed by steel planes. They were well constructed by Messrs. Darling, Brown, and Sharpe. The utmost pains were taken (here as well as in later experiments in Baltimore) to avoid the inclusion of dust between the roller and its support. Nevertheless the decrement of the amplitude was very rapid for arcs above .035 of the radius on each side of the vertical; and the periods show enormous variations.

The experiments on the effect of the bells of the Geneva support are also of interest, though they fail to give a very accurate evaluation of this constant.

The summary of the periods of oscillation at this station (except upon the Geneva support) has already been published in the *Coast Survey Report* for 1881, pages 423–424. This summary is here repeated, with the difference that the flexure corrections are now applied, that some errors of computation are corrected,* and that the experiments relating to the effect of the bells are added.

*The following table shows these corrections:

Support.	Method of observation.	Position heavy end.	Date.	Correction to last figure.	Cause of former error.
Repsold ..	Transits	Up	May 2.	−9	Error in subtraction had occasioned rejection of a transit.
Do.....	Coincidence.	Down.....	Mar. 19.	−9	Error of computation.
Do.....	....do	....do	Mar. 21.	−1	Do.
Stiffest ...	Transits	....do	Apr. 4, *bis.*	−3	Mr. Farquhar thinks he recorded the wrong minute, a fault to which he was liable. Changing the minute a rejected transit is brought into concordance with the others.

In drawing up the summary, besides the corrections for arc, pressure, temperature, and rate, the following have been applied:

Cause.	Authority for amount.	Amount.	
		Heavy end down.	Heavy end up.
Knife, 7–8 (for 3–4, with reversed sign)..	See Ebensburgh report* ..	—.000006	+.000015
Flexure Repsold support	C. S. R., 1881, p. 424	—.000084	—.000036
Flexure stiffest support	C. S. R., 1881, p. 423	—.000022	—.000009
Flexure Geneva support.....	C. S. R., 1881, p. 399	—.000020	—.000009
Flexure wooden support.....	C. S. R., 1881, p. 423	—.000123	—.000054
Flexure rubber support	.....do	—.000300	—.000131
Geneva cylinder.....	C. S. R., 1876, p. 270	—.000004	—.000008
Geneva bells.....	C. S. R., 1876, pp. 270, 271..	—.000012	—.000028

* At the time the paper on the flexure of pendulum supports was drawn up Mr. Smith had not measured the knives. It was consequently necessary to determine this correction *a posteriori* and slightly different corrections were thus used in the synopsis given in that report, viz, —.000004 and +.000012.

Periods of Oscillation at York.

REPSOLD SUPPORT.

Method of transits.

Heavy end down.		Heavy end up.	
	Knife 7–8.		Knife 3–4.
1880.	*s.*	1880.	*s.*
April 7	1.006413	April 7	1.006467
April 30	1.006405	April 30	1.006446
	Knife 3–4.		Knife 7–8.
May 2	1.006418	May 2	1.006483
May 3	1.006418	May 3	1.006483

Method of coincidences.

	Knife 3–4.		Knife 7–8
March 19	1.006432	March 19	1.006490
March 21	1.006407	March 21	1.006440
June 4	1.006413	June 4	1.006472
June 5	1.006407	June 4	1.006450
	Knife 7–8.		Knife 3–4.
March 22	1.006422	March 22	1.006488
March 23	1.006406	March 23	1.006494
June 6	1.006421	June 6	1.006472
June 6	1.006429	June 6	1.006466

STIFFEST SUPPORT.

Method of transits.

Heavy end down.		Heavy end up.	
	Knife 3–4.		Knife 7–8.
	s.		*s.*
March 31	1.006415	March 31	1.006467
April 2	1.006419	April 2	1.006472
	Knife 7–8.		Knife 3–4.
April 4	1.006410	April 4	1.006471
April 4	1.006417	April 4	1.006463

Method of coincidences.

	Knife 7–8.		Knife 3–4.
March 26	1.006419	March 26	1.006456
March 27	1.006423	March 27	1.006463
	Knife 3–4.		Knife 7–8.
March 28	1.006417	March 28	1.006461
March 29	1.006415	March 29	1.006463

WOODEN SUPPORT.

Method of coincidences.

	Knife 7–8.		Knife 3–4.
April 24	1.006420	April 24	1.006473
April 25	1.006417	April 25	1.006469
	Knife 3–4.		Knife 7–8.
April 27	1.006415	April 27	1.006470
April 28	1.006417	April 28	1.006488

RUBBER SUPPORT.

Method of coincidences.

	Knife 7–8.		Knife 3–4.
	s.		*s.*
April 18	1.006404	April 18	1.006484
April 20	1.006401	April 20	1.006482

GENEVA SUPPORT; BELLS OFF.

Method of transits.

	Knife 3–4.		Knife 7–8.
May 19	1.006425	May 19	1.006499
	Knife 7–8.		Knife 3–4.
May 22	1.006420	May 22	1.006488

Method of coincidences.

	Knife 3–4.		Knife 7–8.
May 18	1.006433	May 18	1.006509
	Knife 7–8.		Knife 3–4.
May 23	1.006431	May 23	1.006463

GENEVA SUPPORT; BELLS ON.

Method of coincidences.

	Knife 7–8.		Knife 3–4.
May 26	1.006432	May 26	Rejected.
May 27	1.006439	May 27	1.006485
May 29	1.006430	May 29	1.006459
	Knife 3–4.		Knife 7–8.
May 30	1.006432	May 30	1.006507
May 31	1.006437	May 31	1.006488

The means of the observed periods for the Repsold and stiffest supports are—

Method of transits.

	Heavy end down.	Heavy end up.
	s.	*s.*
Repsold support	1.006413 ± 1	1.006470 ± 5
Stiffest support	1.006415 ± 1	1.006468 ± 1
Weighted mean	1.006414 ± 1	1.006468 ± 1

Method of coincidences.

Repsold support	1.006417 ± 3	1.006471 ± 5
Stiffest support	1.006419 ± 2	1.006461 ± 1
Weighted mean	1.006418 ± 2	1.006462 ± 1
General mean	1.006416 ± 1	1.006465 ± 1

It will be seen that the method of eye and ear coincidences is greatly inferior in accuracy, the eight observations taken in this way on the Repsold support being less valuable than the four by transits; and there can be little doubt that the means would be brought nearer to the truth by rejecting all the observations by these coincidences. We shall accordingly allow observations with this method only one-fourth weight. With these weights, the above periods become—

Corrected periods 1.006415 1.006468

The observations on the Geneva support, with the bells off, give

Heavy end down.	Heavy end up.
s.	s.
1.006424	1.006492

The differences from the corrected periods just ascertained are—

+.000009 +.000024

These numbers are in such a proportion as to indicate some force acting equally on the pendulum in its two positions. Experiments subsequently made in Baltimore, to be described in another memoir, leave no doubt that the effect is connected with the supporting planes of the Geneva receiver.

The observations with the bells on, all made by the method of coincidences, give—

Heavy end down.	Heavy end up.
s.	s.
1.006435	1.006485

From these numbers it would seem that the effect of the bells may be a little larger than was calculated; but the error, if any, can hardly be sensible when the receiver is pumped out.

The time observations were made with the same transit instrument used at Hoboken and at Ebensburgh. The eye-piece not being quite steady, the variations of collimation were considerable, and the instrument could not be kept free from dust. Time was kept by the four chronometers:

Negus 1589
Frodsham 2490
Hutton 202
Bond 380

They seem to have required cleaning, and show large diurnal variations. An attempt was made in the computations to take account of these, but not successfully.

The measurement of the pendulum on March 3 showed—

Pendulum—standard=+26.μ9

On May 7 and 8 three sets were taken with heavy end up, on which account 1. 0 has to be added to the results. (See "Measurements of Gravity at Initial Stations.") With this correction the results are as follows:

	μ.
Pendulum—standard=	+26.9
	+23.4
	+25.8
Mean	+25.3

On June 9, the knives having been interchanged, four sets gave

	μ.
Pendulum—standard=	+27.8
	+25.5
	+31.3
	+30.0
Mean	+28.6

These figures are uncorrected for the difference of thermometers on the pendulum and standard, because such correction would make the accordance of the measures much less good. We must assume the excess of length of the pendulum in the first position to have been +26$^{\mu}$.1, and for the mean of the two positions +27$^{\mu}$.3. Since the standard is +261 .1 longer at 15° C. than the assumed meter, it follows that the length of the pendulum in terms of that meter (now known to be false) was

$$1^{m}.0002884$$

I prefer to retain the erroneous meter for the present, in order to avoid further confusion.

The difference of the distances of the center of mass from the two edges was found to be

Date.	Knife, 3-4 at heavy end.	Knife, 7-8 at heavy end.	First roller at heavy end.	Second roller at heavy end.
	m.	m.	m.	m.
March 22	0.39343	0.39353		
March 28	0.39340	0.39349		
April 26	0.39353	0.39351		
May 10			0.39388	0.39387
May 30	0.39344	0.39353		
Means	0.39345	0.39351		

In the mean of the two positions of the knives we have 0.39348, to which .00014 has to be added on account of the error of the standard. (See "Measurements of Gravity at Initial Stations.")

The following is the calculation of the length of the seconds' pendulum at York:

T_d	1.006415	T_u	1.006468
T_d^2	1.012871	T_u^2	1.012978
$\frac{1}{2}(T_d^2+T_u^2)$	1.012925	Corr. stretching	1.012979
$\frac{1}{2}(T_d^2-T_u^2)$	−54		
$\frac{h_d+h_u}{h_d-h_u}\frac{1}{2}(T_d^2-T_u^2)$	−137		
[T^2 Rev.]	1.012788		

Whence the length of the seconds' pendulum in York referred to the meter heretofore used is:

	$0^{m}.993073$
Provisional correction to meter	−16
Elevation	+104
Latitude	−2146
Reduced to sea-level and equator	0.991015

These reductions have been made, like those of Allegheny, in accordance with the principles of my memoir on the ellipticity of the earth (Coast Survey Report for 1881, Appendix No. 15).

Details of the work at York are printed in tables appended to the edition of this Appendix which has been published separately.

DETAILS OF DETERMINATIONS OF GRAVITY AT THE ALLEGHENY OBSERVATORY, PENNSYLVAIA, IN 1879.

ALLEGHENY CLOCK CORRECTIONS, 1879.

Date.	Epoch.	Correction.	*a*.	*b*.	e^1.
	h. m.	*m. s.*			
Feb. 10	4 36	+3 53.23	+1.17	−.16	+.60
13	7 5	59.68	+1.28	−.21	+.60
14	7 16	4 1.87	+1.28	−.21	+.60
15	5 18	4.43	+1.37	−.23	+.60
16	5 45	6.84	+1.58	−.20	+.60
21	5 38	18.92	.....	.....	.....
The above were furnished by the observatory. The following I computed from the notes given:					
Feb. 4	4 40	+3 39.19	+1.25	−.20	+.60
6	8 47	43.94	+1.30	−.17	+.60
7	5 09	46.07	+1.25	−.25	+.60
8	5 15	48.57	+1.07	−.16	+.60
9	5 18	51.17	+1.32	−.29	+.60

Allegheny comparisons of timepieces.

After having received the clock corrections for February 21 and 22 it was decided to adopt the clock 1358 as standard from February 15, $8^h\ 2^m$, to February 21, $7^h\ 12^m$, and the rate between these two epochs was determined by least squares to be $+.100^s$ per hour.

We then have the following corrections to F 1358:

Date.	Epoch.	Correction.	Date.	Epoch.	Correction.	Date.	Epoch.	Correction.
	h. m.	*m. s.*		*h. m.*	*m. s.*		*h. m.*	*m. s.*
Feb. 15	8 2	+3 64.69	Feb. 17	19 32	+3 70.64	Feb. 19	19 25	+3 75.42
	19 8	65.80	18	1 00	71.18	20	1 3	76.99
16	1 3	66.39		6 54	71.77		7 5	76.59
	6 53	66.97		19 51	73.06		19 31	77.84
	19 33	68.24	19	1 34	73.63	21	1 4	78.39
17	1 44	68.86		7 46	74.25		7 12	79.00
	8 14	69.51						

Chronometer comparisons, Allegheny, Pa.

Date.	Epoch by Howard mean time clock.	Seconds by F of exact minute by chronometer.			Date.	Epoch by Howard mean time clock.	Seconds by F of exact minute by chronometer.			Date.	Epoch by Howard mean time clock.	Seconds by F of exact minute by chronometer.		
		380.	202.	1589.			380.	202.	1589.			380.	202.	1589.
1879.	*h.*	*s.*	*s.*	*s.*	1879.	*h.*	*s.*	*s.*	*s.*	1879.	*h.*	*s.*	*s.*	*s.*
Feb. 4	4.0	36.52	35.50	52.59		21.9	36.06	20.18	44.73		21.5	39.89	5.11	36.73
	9.4	36.51	34.89	52.34	Feb. 10	4.0	36.18	19.68	44.51	Feb. 16	3.3	40.09	4.40	36.29
	21.3	36.48	33.50	51.59		9.8	36.34	19.10	44.39		9.2	40.47	3.76	35.90
5	3.5	36.38	32.79	51.15		21.4	36.44	17.88	43.80		21.8	40.96	2.40	35.01
	9.5	36.31	32.17	50.82	11	3.4	36.41	17.16	43.45	17	4.0	41.19	1.80	34.79
	21.3	36.01	30.81	50.09		9.5	36.57	16.58	43.03		10.5	41.67	1.23	34.49
6	2.3	35.98	30.34	49.87		21.5	36.90	15.40	42.29		21.7	42.43	0.21	33.93
	8.4	35.95	29.78	49.57	12	3.4	36.97	14.80	41.94	18	3.2	42.79	59.67	33.77
	21.7	35.78	28.29	48.77		9.4	37.18	14.18	41.59		9.0	43.28	59.13	33.59
7	3.2	35.59	27.58	48.40		21.9	37.52	12.92	40.87		22.0	44.40	57.97	33.29
	10.4	35.71	26.70	47.99	13	3.8	37.62	12.40	40.59	19	3.7	44.90	57.54	33.13
	21.3	35.90	25.51	47.45		9.7	37.86	11.79	40.30		9.8	45.50	56.98	32.99
8	3.1	35.80	24.80	47.14		21.5	38.19	10.69	39.69		21.5	46.56	56.04	32.78
	9.1	35.92	24.17	46.79	14	3.2	38.30	10.06	39.39	20	3.1	47.15	55.68	32.73
	21.7	35.89	22.84	46.02		9.9	38.60	9.36	39.07		9.1	47.83	55.13	32.68
9	3.2	35.73	22.16	45.68		21.5	38.93	8.00	38.39		21.5	49.07	54.28	32.59
	9.5	35.93	21.45	45.44	15	3.5	39.01	7.24	37.93	21	3.0	49.53	53.77	32.50
						10.4	39.21	6.32	37.35		9.2	50.29	53.35	32.48

Temperature and pressure, Allegheny, Pa., 1879.

The temperature as here given is subject to correction of — 0°.3 F.]

HEAVY END UP.

February 6.		February 6.		February 7.		February 7.	
Time.	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*
19h 2m	0in. 91	0h 55m	1in. 16	19h 20m	1in. 71	2h 16m	0in. 77
22 0	0 .98	8 6	1 .41	25 46	1 82	7 59	0 .77
25 5	1 .16						
	Temp.		*Temp.*		*Temp.*		*Temp.*
19h 11m	33°. 5	2h 13m	33°. 4	19h 57m	32°. 8	2h 21m	33°. 0
25	33 .2	30	33 .4	20 17	32 .9	53	33 .4
56	33 .2	48	33 .2			4 05	33 .1
	33 .20		33 .33			41	33 .0
							33 .12
20 18	33 .2	4 26	32 .9	20 32	32 .9		
40	33 .2	5 8	33 .0	21 30	32 .9	4 41	33 .0
21 6	33 .2	6 0	33 .0			5 58	33 .0
	33 .20		32 .97				33 .00
21 40	33 .2	6 35	33 .0	22 32	32 .8	7 13	33 .0
23 33	33 .2	7 13	33 .0	23 10	32 .8	7 54	32 .9
	33 .20	53	33 .0				32 .95
			33 .00	23 57	33 .0		
				24 40	32 .8		

HEAVY END DOWN.

February 8–9.		February 9–10.		February 13–14.		February 14–15.	
Time.	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*
23h 24m	0in. 50						
6 34	0 .52	22h 28m	0in. 55	7h 28m	0in. 67	1h 51m	0in. 69
22 18	0 .55	22 33	0 .58	25 15	1 .57	21 00	1 .56
	Temp.		*Temp.*		*Temp.*		*Temp.*
1h 18m	33°. 5	1h 1m	32°. 5	7h 53m	34°. 8	1h 58m	31°. 6
2 2	33 .3	14	32 .6	8 3	34 .7	2 7	31 .7
	33. 40	27	32 .6	13	34 .5	39	31 .7
		2 4	32 .7	15	34 .5	51	31 .7
4 7	32 .9	43	32 .8	26	34 .3	3 4	31 .7
			32 .64	28	34 .2		31 .68
				29	34 .0		
6 34	32 .8	3 45	32 .5	30	34 .0	5 1	31 .2
		4 04	32 .5	42	33 .9	16	31 .2
		41	32 .4	44	33 .8	34	31 .1
			32 .47	55	33 .4		31 .17
		7 2	32 .2	9 8	33 .4		
				23	33 .3	7 51	30 .7
8 24	32 .7	8 52	32 .2		33 .83		
19 24	32 .4	8 52	32 .2	18 23	31 .6		
20 44	32 .4	17 45	31 .9			18 18	29 .8
	32 .40		32 .03	20 50	31 .5		
21 48	32 .3	20 28	32 .0	22 53	31 .3		
		22 20	32 .0	1 6	31 .3		

HEAVY END UP.

February 15.		February 16.		February 16.		February 17.	
Time.	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*	*Time.*	*Press.*
2h 1m	0in. 64	20h 15m	0in. 66	2h 41m	0in. 65	2h 11m	0in. 83
8 13	1 .16	26 17	1 .38	9 13	1 .37	8 13	1 .47
	Temp.		*Temp.*		*Temp.*		*Temp.*
2h 14m	31°. 1	20h 23m	30°. 2	2h 54m	30°. 5	2h 28m	30°. 6
28	31 .1	38	30 .2	3 4	30 .5	51	30 .9
44	31 .1	21 15	30 .3	15	30 .6	3 3	31 .0
3 15	31 .0	38	30 .2	32	30 .5	8	31 .0
29	30 .8	47	30 .4	38	30 .5	35	30 .9
37	30 .8	56	30 .4	4 23	30 .5	50	30 .9
	30 .98		30 .28	32	30 .3		30 .88
					30 .49		
5 50	30 .5	23 39	30 .3			4 15	30 .9
		57	30 .2	4 50	30 .4	6 16	30 .7
6 8	30 .4	0 37	30 .1	7 16	30 .2		30 .80
29	30 .4		30 .20		30 .30		
53	30 .3					7 2	30 .7
7 17	30 .2	1 0	30 .1	8 5	30 .4	8 0	30 .8
47	30 .2	26	30 .1	48	30 .5		30 .75
	30 .36	2 1	30 .1		30 .45		
			30 .10				

Comparison of thermometers. Allegheny, Pa., 1879.

Date.	108.	Kew.	P.	Q.	Z.	K.	27071	Reduced.
March 3	2°. 83	2°. 8	2°. 79	2°. 78	2°. 93	3°. 28	36°. 9	2°. 7
	4 .50	4 .5	4 .52	4 .49	4 .68	5 .00	39 .4	4 .1
	7 .60	7 .5	7 .54	7 .52	7 .74	8 .03	45 .8	7 .65
	9 .62	9 .55	9 .63	9 .54	9 .79	10 .11	49 .4	9 .65
March 4	15 .82	15 .8	15 .89	15 .79	15 .99	16 .32	60 .8	16 .0
	15 .91	15 .85	15 .93	15 .87	16 .00	16 .37	60 .8	16 .0
	16 .33	16 .25	16 .32	16 .25	16 .40	16 .77	61 .6	16 .45
	17 .18	17 .0	17 .08	17 .00	17 .24	17 .62	63 .1	17 .3
	17 .00	17 .0	16 .99	16 .94	17 .16	17 .50	63 .1	17 .3
March 5	6 .29	6 .25	6 .30	6 .28	6 .42	6 .75	43 .2	6 .2

REDUCTION TO K.

March 3	+°. 45	+°. 48	+°. 49	+°. 50	+°. 35	.....	.....	+°. 58
	.50	.50	.48	.51	.32	.....	.....	.90
	.43	.53	.49	.51	.29	.....	.....	.38
	.49	.56	.48	.57	.32	.....	.....	.45
March 4	.50	.52	.43	.53	.33	.....	.....	.32
	.46	.52	.44	.50	.37	.....	.....	.37
	.44	.52	.45	.52	.37	.....	.....	.32
	.44	.62	.54	.62	.38	.....	.....	.32
	.41	.50	.51	.56	.34	.....	.....	.20
March 5	.46	.50	.45	.47	.38	.....	.....	.55
Means ..	+.458	+.525	+.476	+.529	+.340	.....	.....	+.439

U. S. C. S. PENDULUM AT ALLEGHENY, PA.

LENGTH I.

Date.	Ther. Z stand.	Ther. Q pend.	Z−Q −.19.	Above— St.	Above— Pend.	Above— P − st.	Below— St.	Below— Pend.	Below— P—st.	Uncorr. P—st.	Corr. for dif. of temp.	Corr'd for temp.	Correc. for micrometer. Above	Correc. for micrometer. Below.	Corr'd co. diff.	Means.
1879.	°	°														
Jan. 18	13.60	13.44	−.03	1,928	2,044	+116	2,069	1,887	−182	+298	− 5	+293	0	+1	+294	
18	13.71	13.60	−.08	1,908	2,016	+108	2,069	1,875	−194	302	−15	287	0	+2	289	
18	13.76	13.56	+.01	1,949	2,002	+ 53	2,073	1,872	−201	254	+ 2	256	0	+2	258	
18	14.22	14.20	−.17	1,920	1,981	+ 61	2,065	1,854	−211	272	−31	241	0	+2	243	
18	15.34	15.21	−.06	1,942	2,011	+ 69	2,090	1,889	−201	270	−11	259	0	+2	261	
18	15.19	15.12	−.12	1,948	1,991	+ 43	2,085	1,887	−198	241	−22	219	0	+2	221	(261)
18	14.89	15.09	−.39	2,086	1,885	−200	1,956	2,020	+ 64	264	−71	193	0	+1	194	Rej.
20	11.47	11.43	−.15	1,815	1,947	+132	2,264	2,060	−204	336	−27	309	0	+2	311	Rej.
20	11.54	11.48	−.13	1,826	1,933	+107	2,266	2,050	−216	323	−24	299	0	+2	301	Rej.
21	3 02	3.16	−.33	1,942	2,191	+249	2,110	2,043	− 67	316	−60	256	0	+1	257	
21	3.21	3.31	−.29	1,941	2,184	+243	2,092	2,045	− 47	290	−53	237	0	0	237	
21	3.44	3.44	−.19	1,946	2,203	+257	2,080	2,049	− 31	288	−35	253	0	0	253	
21	3.63	3.62	−.18	1,929	2,157	+228	2,096	2,051	− 45	273	−33	240	0	0	240	
21	3.73	3.73	−.19	1,929	2,148	+219	2,087	2,045	− 42	261	−35	226	0	0	226	
21	3.52	3 39	−.06	1,958	2,170	+212	2,079	2,032	− 47	259	−11	248	0	0	248	
21	3.62	3.59	−.16	1,930	2,168	+238	2,087	2,038	− 49	287	−29	258	0	0	258	(246)
22	4.64	4.71	−.26	1,861	2,034	+173	2,163	2,016	−147	320	−48	272	0	+1	273	
22	4.71	4.76	−.24	1,878	2,033	+155	2,165	2,022	−143	298	−44	254	0	0	255	
22	4.81	4.88	−.26	1,887	2,045	+158	2,165	2,008	−157	315	−48	267	0	+1	268	
22	4.88	4.92	−.23	1,903	2,049	+146	2,172	2,018	−154	300	−42	258	0	+1	259	
22	5.91	5.95	−.23	1,890	3,046	+156	2,162	2,010	−152	308	−42	266	0	+1	267	
22	5.82	5.86	−.23	1,873	2,136	+261	2,136	2,106	− 30	291	−42	249	0	0	249	
22	6.04	6.11	−.26	1,853	2,131	+276	2,144	2,093	− 51	327	−48	279	0	0	279	(264)
23	4.66	4.69	−.22	1,946	2,024	+ 78	2,154	1,986	−168	246	−40	206	0	+1	207	
23	4.76	4.82	−.25	1,941	2,028	+ 87	2,149	1,979	−170	257	−46	211	0	+1	212	
23	4.94	5.00	−.25	1,878	2,092	+214	2,089	2,046	− 43	257	−46	211	0	0	211	
23	5.17	5.35	−.37	1,852	2,066	+214	2,087	2,053	− 34	248	−68	180	0	0	180	
23	5.58	5.80	−.31	1,838	2,042	+204	2,078	2,038	− 40	244	−57	187	0	0	187	
23	5.83	5.98	−.34	1,840	2,068	+228	2,078	2,041	− 37	265	−62	203	0	0	203	(200)

Final mean + 24.″3.

LENGTH II.

Date.	Ther. Z stand.	Ther. Q pend.	Z−Q −.19.	Above— St.	Above— Pend.	Above— P−st.	Below— St.	Below— Pend.	Below— P—st.	Uncorr. P—st.	Corr. for diff. of temp.	Corr'd for temp.	Correc. for micrometer. Above	Correc. for micrometer. Below.	Corr'd diff.	Means.
1879.	°	°														
Jan. 25	18.89	18.65	+.05	1,927	2,112	+185	2,099	2,056	− 43	+228	+ 9	+237	0	0	+237	
25	18.93	18.73	+.01	1,920	2,092	+172	2,086	2,041	− 45	217	+ 2	219	0	0	219	(228)
27	13.63	13.44	00	1,994	2,053	+ 89	2,131	1,996	−135	224	0	224	0	+1	225	Rej.
28	16.19	15.75	+.25	1,849	2,180	+331	2,253	2,145	−108	439	+46	485	0	+1	486	Rej.
28	18.55	18.15	+.21	2,022	2,141	+119	2,241	2,156	− 85	204	+38	242	0	+1	243	Rej.
28	18.38	17.96	+.23	2,023	2,119	+ 96	2,244	2,128	−116	212	+42	254	0	+1	255	Rej.
29	10.29	10.12	−.02	1,946	2,117	+171	2,225	2,131	− 94	265	+ 4	269	0	+1	270	Rej.
29	11.13	10.88	+.06	1,877	1,952	+ 75	2,206	2,038	−168	243	+11	254	0	+1	255	
29	11.36	10.95	+.22	1,849	1,976	+127	2,113	2,038	− 95	222	+40	262	0	+1	263	(255)
29	11.27	10.91	+.17	1,858	1,972	+114	2,136	2,034	−102	216	+31	247	0	+1	248	
30	6.88	6.88	−.19	1,848	2,052	+204	2,091	2,097	+ 06	198	+35	Rej.	0	0		
30	7.04	6.99	−.14	1,878	2,051	+173	2,149	2,109	− 40	213	+26	Rej.	0	0		
31	19.14	18.89	+.06	1,921	1,976	+ 55	2,131	1,976	−155	210	+13	223	0	+1	224	
31	19.03	18.80	+.04	1,901	1,965	+ 64	2,128	1,961	−167	231	+ 9	240	0	+1	241	(232)
Feb. 1	11.59	11.26	+.14	1,922	1,924	+ 2	2,119	1,963	−156	158	+26	184	0	+1	185	
1	11.54	11.21	+.14	1,916	1,916	0	2,123	1,962	−161	161	+26	187	0	+1	188	(186)

Final mean + 22.″5.

LENGTH III.

Date.	Ther. K on stand.	Ther. Q on pend.	K−Q −.53 (K−Q =+.53)	Above— Stand.	Pend.	P−st.	Below— Stand.	Pend.	P−st.	Uncorr. diff.	Corr. for diff. temp.	Corr'd for diff. temp.	Correc. for micrometer. Above.	Below.	Corr. diff.	Means
1879.	°	°	°													
Feb. 22	3.18	2.91	−.26	1,947	2,136	+189	2,071	2,104	+ 33	+156	− 47	+109	0	0	109	.....
22	3.31	3.03	−.21	1,931	2,120	+189	2,062	2,097	+ 35	+154	− 38	+116	0	0	116	113
23	3.00	2.71	−.24	1,984	1,981	− 3	2,098	1,961	−137	+134	− 44	+ 90	0	−1	91	.....
23	3.02	2.70	−.21	1,978	1,987	+ 9	2,090	1,948	−142	+151	− 38	+113	0	−1	114	102
24	2.29	2.07	−.31	1,927	1,950	+ 23	2,066	1,931	−135	+158	− 56	+102	0	−1	103	.....
24	2.36	2.21	−.38	1,912	1,946	+ 34	2,065	1,936	−129	+163	− 69	+ 94	0	−1	95	99
25	1.80	1.63	−.36	1,915	1,977	+ 62	2,075	1,994	− 81	+143	− 66	+ 77	0	0	77	.....
25	1.94	1.75	−.34	1,914	1,983	+ 69	2,080	1,983	− 97	+166	− 62	+104	0	0	104	91
26	7.39	8.89	−2.03	1,774	2,038	+264	2,087	1,965	−122	+386	−369	+ 17	0	0	*17	.....
26	8.94	10.46	−2.05	1,745	2,018	+273	2,098	1,977	−121	+394	−373	+ 21	0	0	*21	.....
26	14.75	14.42	−.20	1,965	1,944	− 21	2,110	1,890	−220	+199	− 36	+163	0	−1	†164	.....
26	12.02	10.07	+1.42	2,202	1,941	−261	2,132	1,944	−188	− 73	+258	+185	0	−1	†186	.....
26	11.02	9.85	+1.24	2,180	1,925	−255	2,132	1,911	−221	− 34	+226	+192	0	−1	†293	....
26	8.45	7.20	+ .72	2,161	1,964	−197	2,134	1,927	−207	+ 10	+131	+121	0	−1	122	.....
26	8.35	7.34	+ .48	2,101	1,948	−153	2,124	1,932	−192	+ 39	+ 87	+126	0	−1	127	.....
26	7.97	7.16	+ .28	2,033	1,923	−110	2,086	1,915	−171	+ 61	+ 51	+112	0	−1	113	121
27	6.05	6.22	−.70	1,907	1,934	+ 27	2,079	1,918	−161	+188	−127	+ 61	0	−1	‡62	.....
28	4.47	4.06	−.12	1,976	1,876	−100	2,056	1,869	−187	+ 87	− 22	+ 65	0	−1	‡66	.....
28	4.54	4.16	−.15	1,960	1,870	− 90	2,057	1,857	−200	+110	− 27	+ 83	0	−1	‡84	.....
Mar. 1	4.26	4.06	−.33	1,894	2,018	+124	2,109	2,032	− 77	+201	− 60	+141	0	0	141	.....
1	4.35	4.11	−.29	1,895	2,023	+128	2,103	2,018	− 85	+213	− 53	+160	0	0	160	150
2	4.37	4.10	−.26	1,929	2,113	+184	2,080	2,103	+ 23	+161	− 47	+114	0	0	114	.....
2	4.43	4.12	−.22	1,930	2,102	+172	2,087	2,100	+ 13	+159	− 40	+119	0	0	119	116

Final mean + 11.$^{\mu}$3.

The rejections have in all cases been made on account of too great a change in temperature or bad focus.

CENTER OF MASS.

Date.	Knife at heavy end and fig. for.	Pos. of name.	Heavy end. Read in middle.	Heavy end. Read at end.	Read in middle.	Read at end.	h_4-h_8.
1879. Feb. 10	No. 2 marks for'd.	Up.	17056	.00931	56040	.00615	39303
			50	30	049	615	
		Down	17056	.00935	56040	613	
			56	37	040	613	

* Rejected, fire made up. † Rejected, change of temperature. ‡ Rejected, bad focus.

DECREMENT OF AMPLITUDE.

Tables for finding inclination. (*Heavy end down.*)

Arc.	Press., 0in.56, Feb. 9, 10; also, Feb. 8, 9, press. 0in.52.				Press., 0in.94, Feb. 13, 14.				Press., 1in.09, Feb. 14.			
	Time.	Diff.	Adop.	Tab. No.	Time.	Diff.	Adop.	Tab. No.	Time.	Diff.	Adop.	Tab. No.
	h. m.	m.	m.	m.	h. m.	m.	m.	m.	h. m.	m.	m.	m.
380	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
370	.....	.....	.....	.....	.....	.....	.....	.....	3 58	.....	.....	.....
360	3 45	.....	.....	.....	.....	.....	.....	.....	4 09	11	11	11
350	58	13	13	13	.....	.....	.....	.....	20	11	11	11
340	4 11	13	13	13	10 09	.....	.....	.....	31	11	11	11
330	24	13	13	13	19	10	10	10	.....	.....	11	11
320	4 35	11	13	13	31	12	11	11	.....	.....	12	12
310	48	13	13	13	43	12	12	12	5 01	.....	12	12
300	5 00	12	13	13	55	12	12	13	13	12	12	12
290	14	14	14	14	11 08	13	13	13	26	13	12	12
280	27	13	14	14	21	13	13	14	38	12	13	13
270	42	15	14	15	34½	13½	14	15	51	13	13	13
260	56	14	15	16	49	14½	15	16	6 04	13	13	14
250	6 12	16	16	17	12 05	16	16	17	18	14	14	14
240	30	18	17	18	24	19	17	18	35	17	14	15
230	49	19	18	19	42	18	18	18	48	13	15	15
220	7 08	19	19	20	13 00	18	18	19	7 06	18	16	16
210	26	18	20	21	18	18	19	20	20	14	16	16
200	48	22	21	22	39	21	21	22	7 39	19	17	17
190	8 09	21	22	23	14 00	21	23	23	57	18	18	18
180	30	21	23	24	24	24	24	24	8 17	20	19	19
170	54	24	24	25	48	24	25	25	36	19	20	21
160	9 22	28	26	26	15 11	23	25	26	9 00	24	22	23
150	9 47	25	27	27	36	25	27	27	20	20	24	25
140	10 15	28	28	29	16 03	27	28	28	46	26	26	28
130	43	28	30	31	27	24	29	30	10 12	26	30	33
120	11 15	32	32	35	55	28	31	32	50	38	36	39
110	51	38	37	40	17 21	26	33	34	11 30	40	40	43
100	12 33	42	42	47	55	34	35	37	12 10	40	46	49
90	13 24	51	52	57	18 24	29	39	41	13 00	50	50	51
80	14 12	48	62	67	19 05	41	43	44	48	48	52	53
70	15 15	63	72	77	36	31	45	46	14 36	48	54	55
60	16 18	63	82	87	20 24	48	48	51	15 28	52	58	61
50	17 18	60	92	97	21 18	54	54	63	16 36	68	64	67
40	18 35	77	102	107	22 30	72	72	96	17 42	66	70	75
30	20 30	115	112	131	24 30	120	120	135	19 00	78	80	85
20	23 13	163	150	160	27 00	150	150	175	20 30	90	90	95
10	.....	.....	.....	.....	.....	.....	.....	215	.....	.....	.....	105

Tables for finding inclination. (Heavy end up.)

Arc.	Press., 1in.76, Feb. (1).				Press., 0in.77, Feb. (2).			
	Time.	Diff.	Adop.	Tab. No.	Time.	Diff.	Adop.	Tab. No.
	h. m.	m.	m.	m.	h. m.	m.	m.	m.
380								
370				3				4
360				3				4
350				3	5 10			4
340				3	14	4	4	4
330				3	19	5	5	5
320				3	24	5	5	5
310	10 35			3	29	5	5	5
300	39	4	4	4	35	6	5	5
290	1 43	4	4	4	40	5	6	6
280	47	4	4	4	46	6	6	6
270	51	4	4	4	52	6	6	6
260	55	4	4	4	58	6	6	7
250	59	4	5	5	6 15	7	7	7
240	11 05	6	5	5	11	6	7	7
230	11 10	5	5	5	19	8	7	3
220	15	5	5	5	25	6	8	8
210	21	6	6	6	33	8	8	8
200	27	6	6	6	41	8	8	9
190	33	6	6	6	6 49	8	8	9
180	40	7	7	7	58	9	9	9
170	47	7	7	7	7 07	9	9	10
160	55	8	8	8	16	9	10	11
150	02	7	8	8	28	12	11	12
140	12 11	9	9	9	39	11	12	13
130	20	9	9	9	51	12	13	14
120	29	9	10	10	8 06	15	14	15
110	41	12	11	11	18	12	15	16
100	53	12	12	13	33	15	17	18
90	1 07	14	14	14	8 53	20	20	21
80	1 21	14	15	16	9 15	22	22	23
70	39	15	17	18	36	21	24	26
60	57	18	19	21	10 00	24	27	30
50	2 17	20	23	26	33	33	33	34
40	47	30	29	32				39
30	3 22	35	35	39				45
20				47				

Tables for finding inclination. (*Heavy end up*)—Continued.

Arc.	Press., .94, Feb. 6 (1); also for Feb. 15. Press , .90.				Press., 1.27, Feb. 6 (2); also 16, 1.62; also 16, 1.50; also 17, 1.16.			
	Time.	Diff.	Adop.	Tab. No.	Time.	Diff.	Adop.	Tab. No.
	h. m.	m.	m.	m.	h. m.	m.	m.	m.
.0340	.....	.....	.....	.....	4 29½	.....	.....	.....
330	.....	.....	.....	.....	33½	4	4	4
320	.....	.....	.....	.....	36	4. 5	4	4
310	.....	.....	.....	.....	42	4	4	4
300	.....	.....	.....	.....	46	4	4	4
290	.....	.....	.....	.....	51	5	5	5
280	.....	.....	.....	.....	56	5	5	5
270	.....	.....	.....	.....	5 1	5	5	5
260	.....	.....	.....	.....	6	5	5	5
250	.....	.....	.....	6	11	6	6	6
240	.....	.....	.....	6	17	6	6	6
230	.....	.....	.....	6	23	6	6	6
220	.....	.....	.....	7	29	7	7	7
210	.....	.....	.....	7	36	7	7	7
200	.....	.....	.....	8	43	8	8	8
190	.....	.....	.....	8	51	8	8	8
180	.....	.....	.....	8	59	9	9	9
170	10 39	.....	.....	9	6 08	9	9	9
160	48	9	9	9	17	10	10	10
150	58	10	10	10	27	10	10	10
140	11 09	11	11	11	37	10	10	10
130	19	10	12	12	47	10	11	11
120	31	12	13	13	58	11	11	11
110	45	14	14	14	7 09	11	12	12
100	57	12	15	15	7 21	12	12	12
90	12 12	15	16	17	35	14	13	14
80	30	18	18	.....	52	17	15	16
70	.....	.....	.....	24	8 9	17	17	18
60	.....	.....	.....	.....	30	21	20	22
50	.....	.....	.....	27	53	23	23	28
40	.....	.....	.....	.....	9 15	22	33	38
30	.....	.....	.....	33	58	43	43	48
20	.....	.....	.....	.....	10 45	47	53	59

$$\text{Inclination} = \frac{\frac{dt}{2}}{\frac{\text{Tab. No.}}{10}} = 5\,dt \div \text{Tab. No.}$$

Inclination.

Arc.	Feb. 6 (2), 1.27.		Feb. 6 (1), .94.		Feb. 7 (1), 1.76.		Feb. 7 (2), .77.		Feb. 8–9, .52.		Feb. 9–10, .56.	
	dt.	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*
.0360				(*)							7	+2.7
350							2	+2.5			6	2.3
340	5	+6.2									5	1.9
330	5.5	6.9					3	3.0				
320							3	3.0	6	+2.3	7	2.7
310					4	+6.7			7	2.7.	6	2.3
300							2	2.0	7	2.7	7	2.7
290							2	1.7	7	2.5	7	2.5
280	6	6.0			2	2.5			6	2.1	8	2.9
270	6	6.0							5	1.7		
260	7	7.0							7	2.2		
250	7	5.8										
240	7.5	6.2									9	2.5
230					3	3.0					9	2.4
220					4	4.0						
210												
200												
190					3.5	2.9						
180					4	2.9	3	1.7				
70					11	3.1						
60					12.5	3.0	12	2.0				
50	34	6.1			18	3.5	10	1.5				
40					23	3.6						
Means..		+6.3		+5.0		+3.5		+2.2		+2.3		+2.5

Arc.	Feb. 13–14, 0.94.		Feb. 14, 1.09.		Feb. 15, 0.90.		Feb. 16, 1.62.		Feb. 16, 1.50.		Feb. 17, 1.16.	
	dt.	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*	*dt.*	*dϕ.*
.0370			3	+1.4								
360			2	0.9					6	−7.5		
350			1	0.5			7	−8.7				
340	1	−0.5	2	0.9							6	−7.5
330	1	−0.5							5	6.2	5	6.2
320	2	−0.9			6	−7.5			7	8.7	6	7.5
310	2	−0.5	1	0.4			6	7.5	6	7.5	5	6.2
300	2	0.8	2	0.8	6	7.5	6	7.5	7	8.7	6	6.0
290	1	0.4	1	0.4	7	7.0	8	8.0	6	6.0	6	6.0
280	1	0.4	1	0.4	7	7.0	7	7.0	7	7.0		
270	1	0.3	2	0.8	7	7.0			7	7.0	8	8.0
260	1	0.3	2	0.7	8	8.0	7	7.0	8	8.0	7	7.0
250					7	5.8	7.5	5.4			7	5.8
240					8	6.7	7.5	5.4			8	6.7
230					8	6.7	9	7.5			8	6.7
220					9	6.4						
50							32	5.7				
40							40	5.3	43	5.7	41	5.4
Means..		−0.5+		+0.7		−7.0		−6.8		−7.2		−6.6

* Increase taken from notes.

Times of reaching different amplitudes.

	Heavy end up.									Heavy end down.				
	Feb. 6. Bar., 0.94 in.		Feb. 6. Bar., 1.27 in.		Feb 7. Bar., 1.76 in.		Feb. 7. Bar., 0.77 in.		Arc.	Feb. 8–9 Bar., 0.52 in.		Arc.	Feb. 9–10. Bar., 0.56 in.	
L (=N) or R (=S).	L	R	L	R	L	R	L	R		L	R		L	R
.0370			1h										1h	
360							2h						2m.2	9.1
350				35m.9			23m	24m.1		0h			15.6	21.2
340			35m.0	40.2	19h								28.1	33.5
330			39.1	44.4			31.3	34.0		50m.2	57m.5			46.5
320			43.4			44m.1	36.3	38.7		66.0	71.5		52.5	59.5
310				53.6	44m.8	47.7	44.0			78.1	85.6		65.3	71.5
300			52.5		49.3		47.0	49.1		92.9	99.7		77.4	84.6
290				62.7		55.4	52.5	54.5		107.1	114.0		91.5	98.6
280			61.4	67.3	56.7	59.1				122.8	129.1		105.3	112.5
270	18h		66.2	72.5	61.3	63.1				137.9	143.2			
260			71.3	78.3						152.8	160.6			
250	51m.5	59m.6	76.8	84.0		73.1								
240		64.7	82.3	90.9	74.7	78.4							167.5	176.7
230	61.0*	71.5	89.0		80.3	83.0							186.5	196.4
220	69.5				85.4	89.3							205.4	
210	77.2	85.1	101.7		91.0	96.2							223.9	
200	83.0		108.7		96.5	100.9				267.6				
190	91.3	102.3			104.5	108.1		125.3						
180	100.6*				110.7	115.2								
170	108.0				118.1	121.5								
160	116.8				125.3									
150	126.5				132.6		159.0						365.4	
140	137.6				142.0					415.2				
130	147.8				150.6									
120	159.7				159.7									
110	173.7*				171.0				.0115	502.		.0115	472	
100	185.8		206.5		183.2									
90	201.1		221.0				245.3							
80	219.3		238.1		211.5		267.0							
70			254.6		229.1	240.4	288.6							
60	260.3			304.5	248.2	260.5	313.3	324.7						
50			299.5	332.9	267.6	285.8	345.8	355.6						
40				371.0	332.3				.0033½		1092	35		1005
30		419.8	364.1	424.6					29½		1167	30	1005	
20			411.5						28½	1092		25½		1168
									23	1167		20	1168	1280
									20		1312	14	1280	
									16	1312				

* Too late.

Times of reaching different amplitudes—Continued.

L (=N) or R (=S). Arc.	Heavy end down.				Heavy end up.							
	Feb. 13–14. Bar., 0.94 in.		Arc.	Feb. 14–15. Bar., 1.09 in.	Feb. 15. Bar., 0.90 in.		Feb. 16. Bar., 1.62 in.		Feb. 16. Bar., 1.50 in.		Feb. 17. Bar., 1.16 in.	
	L	R		L	R	L	R	L	R	L	R	L	R
.0380	7h			1h	27m.1	2h		20h		2h35m.6		2h	
370				33m.9	36 .1			3m.1		39 .3		19 .8	
360				44 .1	46 .7	17m.3		7 .1		44 .2	38m.6		18m.6
350				56 .0	56 .8		16m 9	12 .6	6m.1			28 .3	
340	42m.7	41m.7		66 .6	68 .1			17 .6		53 .9		33 .0	27 .6
330	52 .7	51 .8			79 .1	31 .6		22 .3		58 .4	53 .2	37 .1	31 .8
320	64 .4	63 .1			89 .8	37 .1	31 .2	26 .7		63 .8	57 .5	41 .7	36 .1
310	77 .3	75 .0		99 .0	100 .2	42 .8	36 .8	31 .8	25 .7	69 .3	62 .3	46 .5	41 .0
300	88 .5	87 .2		110 .3	113 .8	47 .9	42 .3	37 .6	30 .8	74 .6	68 .2	51 .5	45 .8
290	102 .1	100 .7		124 .8	125 .6	53 .8	46 .9	44 .0	36 .4	80 .5	73 .6	56 .7	50 .4
280	114 .9	114 .2		136 .4	138 .2	59 .7	53 .1	49 .6	42 .5	86 .0	79 .2	62 .5	55 .2
270	128 .6	127 .3		149 .4	151 .5	65 .9	59 .3	55 .8		92 .2	84 .9	67 .9	60 .4
260	143 .4	142 .3		163 .2	164 .9	72 .4	64 .7	61 .6	54 .1	98 .5	90 .6	73 .6	66 .6
250						79 .1	71 .2	67 .3	60 .4		97 .4	79 .8	72 .2
240						85 .8	78 .2	74 .2	66 .7			86 .1	78 .6
230						93 .0	85 .2	81 .9	73 .4			92 .8	84 .1
220						100 .7	92 .2	89 .3				99 .8	
210						109 .3		97 .6				107 .8	
200				257 .9				106 .7		143 .4		115 .8	
190				276 .6				115 .2		151 .9		124 .2	
180				296 .4						160 .4		131 .6	
170								132 .2					
160													
150													
140													
130				411 .2									
120													
110													
100						234 .3		218 .1					
90						253 .5		236 .5					
80						273 .6		255 .7				259 .2	
70						298 .3		276 .9		315 .5		279 .1	
60						321 .2		299 .8		342 .5		303 .2	
57½	683		50			352 .9		329 .8	298 .0	370 .1		332 .5	
56½		683	40				349 .6	360 .0	325 .8	408 .2	365 .4	368 .3	327 .1
37	830		30						361 .0		399 .0		361 .2
35½		830	20										
26	953												
25		953											
21					1058								
19½				1058									
17	1088												
16½		1088											
13½					1100								
11				1180									

Observed times of decrement.

L (N) or R (S). Arc.	Heavy end up.								Heavy end down.			
	Feb. 6. Bar., .94 in.		Feb. 6. Bar., 1.27 in.		Feb. 7. Bar., 1.76 in.		Feb. 7. Bar., 0.77 in.		Feb. 8. Bar., .51 and .53		Feb. 9. Bar., .56	
	L	R	L	R	L	R	L	R	L	R	L	R
	9h		4h		10h		5h		3h		3h	
.0380												
370												
360											45	52
350				30			10	12			58	64
340			29m. 5	34. 5							71	76
330			33 . 5	39			19	22		43		89
320			38			34	24	27	51	57	95	102
310				47	35	39	32	35	64	71	108	114
300			46		39		37		78	85	120	127
290				57		46	40	42	92	99	134	141
280			56	62	47	49			108	114	147	155
270			61	67	51				123	128		
260			66	73					138	145		
250	51m		71	78		63						
240			77	84. 5		69					210	219
230			83		70	73					229	238
220					75	79					248	
210	74		96		81						266	
200			103						252			
190	94				93. 5	97		113				
180					100	104	118	121				
170	99m				107		127					
160	108				115							
150	118				122. 5		148				407	
140	129				131. 5				401			
130	139				140. 5							
120	151				149. 5				487		517	
110	165				161							
100	177		201		173							
90	192		215				233					
80	210		232		201		255					
70			249		219	230	276		Feb. 9		Feb. 10	
60				298	237. 5	250	300	312				
50			293	327	257	275	333	343				
40				365	287	310						1050(35½)
30	471		358	418	322						1050	
20			405								1213	1325
33½										1075		
29½										1150		
28½									1075			
23									1150			
20												
16									1294	1294		
25½												1213
14											1325	

Observed times of decrement—Continued.

L (N) or R (S) Arc.	Heavy end down.				Heavy end up.							
	Feb. 13–14. Bar., .94 in.		Feb. 14. Bar., 1.09 in.		Feb. 15. Bar., .90 in.		Feb. 16. Bar., 1.62 in.		Feb. 16. Bar., 1.50 in.		Feb. 17. Bar., 1.16 in.	
	L	R	L	R	L	R	L	R	L	R	L	R
	10h		3h		4h		22h		4h		4h	
.0380	.....	.....	.....	52	.....	.....	.....	.....	49	.....	.....	.....
370	.....	.....	58	61	.....	.....	19	.....	53	.....	30	.....
360	.....	.....	69	71	36	.....	23	.....	58	52	.....	28
350	.....	.....	80	81	.....	35	29	22	.....	.....	38	.....
340	9	8	91	93	.....	.....	34	.....	68	.....	43	37
330	19	18	.....	103	50	.....	38	.....	72	67	47	42
320	31	29	.....	114	55	49	43	.....	78	71	52	46
310	43	41	121	122	.....	55	48	42	83	77	56	51
300	55	53	133	135	66	60	53	47	89	82	61	55
290	68	67	146	147	72	65	60	52	94	88	66	60
280	81	80	158	159	78	71	66	59	100	93	72	65
270	94.5	93.5	172	174	84	77	72	.....	106	99	78	70
260	109	108	184	186	91	83	77	70	112	104	83	76
150	.....	.....	.....	.....	97	90	83½	76	.....	111	89	82
240	.....	.....	.....	.....	104	96	90	82½	.....	.....	96	88
230	.....	.....	.....	.....	111	103	98	89	.....	.....	102	94
220	.....	.....	.....	.....	119	110	105	.....	.....	.....	110	.....
210	.....	.....	.....	.....	126?7	.....	113	.....	.....	.....	117	.....
200	.....	.....	279	.....	.....	.....	122	.....	157	.....	125	.....
190	.....	.....	297	.....	.....	.....	131	.....	166	.....	.....	.....
180	.....	.....	317	.....	.....	.....	.....	.....	174	.....	141	.....
170	.....	.....	.....	.....	.....	.....	148	.....	184	.....	.....	.....
160	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
140	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
130	.....	.....	432	.....	.....	.....	.....	.....	.....	.....	.....	.....
120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
110	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
100	.....	.....	.....	.....	252	.....	234	.....	.....	.....	.....	.....
90	.....	.....	.....	.....	270	.....	252	.....	.....	.....	.....	.....
80	.....	.....	.....	.....	291	.....	271	.....	.....	.....	268	.....
70	.....	.....	.....	.....	315	.....	292	.....	329	.....	288	.....
60	.....	.....	.....	.....	339	.....	315	.....	355	.....	312	.....
50	.....	.....	.....	.....	370	.....	345	313	383	.....	341	.....
40	.....	.....	.....	.....	.....	367	381	341	421	378	377	336
30	Feb. 14	.....	.....	.....	.....	.....	.....	376	.....	412	.....	370
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
57½	646	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
56½	.....	646	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
37	793	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
35½	.....	793	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	915	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	.....	915	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	1049	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16½	.....	1049	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
21	.....	.....	.....	1057	.....	.....	.....	.....	.....	.....	.....	.....
19½	.....	.....	1057	.....	.....	.....	.....	.....	.....	.....	.....	.....
13½	.....	.....	.....	1209	.....	.....	.....	.....	.....	.....	.....	.....
11	.....	.....	1209	.....	.....	.....	.....	.....	.....	.....	.....	.....

Corrected times of reaching different amplitudes.

Arc.	Heavy end up.				Arc.	Heavy end down.		Change of Knives. Arc.	Heavy end down		Heavy end up.			
	Feb. 6. Bar., .94 in.	Feb 6. Bar., 1.27 in.	Feb. 7. Bar., 1.76 in.	Feb. 7. Bar., .77 in.		Feb. 8–9. Bar., .52 in.	Feb. 9–10. Bar., .56 in.		Feb. 13–14. Bar., .94 in.	Feb. 14. Bar., 1.09 in.	Feb. 15. Bar., .90 in.	Feb. 16. Bar., 1.62 in.	Feb. 16. Bar., 1.50 in.	Feb. 17, Bar., 1.16 in.
.0380	9h	4h	10h	5h		3h	3h		10h	3h.51	4h	22h	4h.46	4h
370										.60		.16	.50	.27
360							.48			.70	.33	.20	.55	.31
350		.28		.11			.61			.80	.38	.25		.35
340		.32					.73		8	.92		.31	.65	.40
330		.36		.20		.49	86		.18	1.02	.47	.35	.70	.45
320		.40	.33	.26		.54	.98		.30	1.13	.52	.40	.74	49
310		.45	.37	.34		.67	1.11		.42	1.22	.58	.45	.80	.53
300		.48	.40	.38		.81	1.23		.54	1.34	.63	.50	.85	.58
290		.54	.45	.41		.95	1.37		.67	1.47	.68	.56	.91	.63
280		.59	.48			1.11	1.51		.80	1.58	.74	.63	.96	.68
270		.64	.52			1.25			.94	1.73	.80	.69	1.03	.74
260		.70				1.41			1.08	1.85	.87	.73	1.08	.79
250	.48	.75	.61								.93	.80	1.15	.85
240		.81	.67				2.15				1.00	.86		.92
230		.87	.72				2.33				1.07	.94		.98
220			.77				2.53				1.15	1.00		1.05
210	.70	1.00	.83				2.71				1.21	1.08		1.12
200		1.08				2.57				2.80		1.17	1.51	1.20
190	.90		.95	1.11						2.98		1.26	1.60	
180			1.02	1.20						3.18			1.68	1.35
170	1.03		1.09	1.29								1.42	1.78	
160	1.12		1.18											
150	1.23		1.25	1.51			4.14							
140	1.34		1.35			4.07								
130	1.45		1.44					57½		4.34				
120	1.57		1.53		0.115	4.96	5.26	56½	6.43					
110	1.72		1.65		35½		10.20	37	7.88					
100	1.84	2.09	1.78		33½	10.49		35½	7.98		2.44	2.26		
90	2.00	2.24		2.38	29½	10.85		26	9.07		2.60	2.42		
80	2.19	2.42	2.07	2.60	28½	11.06		25	9.23		2.80	2.60		2.57
70		2.50	2.25	2.82	25½		11.77	21		10.50	3.02	2.80	3.16	2.76
60		2.84	2.44	3.09	23	11.85	12.64	19½		10.64	3.24	3.00	3.39	2.97
50		3.10	2.66	3.38	20	12.57		17	10.40		3.50	3.29	3.63	3.23
40		3.41	2.98		16	13.33		16½	10.58		3.94	3.61	4.00	3.56
30	3.55	3.88	3.36		14		13.69	13½		12.02		4.09	4.47	4.02
20		4.42						11		12.16				
10										12.20				

PERIODS OF OSCILLATION.

KNIFE No. 2.

HEAVY END UP.

Date.	Time of transit.	No. of trans.	Arc.	Adopted interval.	Corr. arc.	Corrected interval.	No. of oscillations.	Time of one oscillation.	Rate.	Expansion.	Atmos.	Corrected period.
	h. m. s.			s.	s.	s.		s.				s.
Feb. 6	19 07 12.154	100	.0225									
	20 1 35.980	40	.0160	3,263.826	.073	3,263.753	3,245	1.0057791	+131	+1334	+7221	1.0066477
	21 42 11.701	100	.0081	6,035.721	.059	6,035.662	6,001	1.0057761	131	1334	7210	1.0066436
	23 38 35.866	100	.0042	6,984.165	.015	6,984.150	6,944	1.0051821	115	1334	7188	1.0066458
	24 57 24.090	80	.0031	4,728.224	.004	4,728.220	4,701	1.0057903	115	1334	7156	1.0066508
						(21,011.785)	20,891	(1.0057817)				(1.0066466)
	1 55 45.016	100	.0300									
	4 22 33.911	20	.0109	8,808.895	.212	8,808.683	8,758	1.0057871	+115	+1334	+7117	1.0066437
	6 05 54.610	40	.0056	6,200.699	.024	6,200.675	6,165	1.0057867	115	1344	7086	1.0066412
	7 54 35.145	100	.0026	6,520.535	.001	6,520.534	6,483	1.0057895	126	1344	7066	1.0066431
						(21,529.892)	21,406	(1.0057876)				(1.0066428)
7	19 51 54.479	100	.0298									
	20 59 25.955	20	.0171	4,051.476	.133	4,051.343	4,028	1.0057952	+109	+1354	+6953	1.0066368
	21 57 45.199	100	.0109	3,499.244	.042	3,499.202	3,479	1.0058068	109	1349	6948	1.0066474
	23 50 47.310	100	.0044	6,782.111	.023	6,782.088	6,743	1.0057968	109	1339	6942	1.0066358
	1 50 58.908	100	.0023	7,211.598	.004	7,211.594	7,170	1.0058011	134	1339	6934	1.0066418
						(21,544.227)	21,420	(1.0057996)				(1.0066399)
	2 28 17.006	100	.0339									
	4 35 53.205	100	.0156	7,656.199	.253	7,655.946	7,612	1.0057732	+134	+1318	+7286	1.0066470
	6 20 46.475	100	.0081	6,833.270	.056	6,833.214	6,794	1.0057719	134	1324	7250	1.0066427
	7 59 13.262	100	.0047	5,366.787	.013	5,366.774	5,336	1.0057673	134	1326	7243	1.0066376
						(19,855.934)	19,742	(1.0057711)				(1.0066430)

KNIFE No. 1.

HEAVY END DOWN.

Feb. 8	0 54 14.253	100	.0329									
	2 35 03.578	100	.0261	6,049.325	.323	6,049.002	6,013	1.0059874	+129	+1303	+3217	1.0064523
	4 30 49.164	100	.0200	6,945.586	.231	6,945.355	6,904	1.0059900	129	1329	3217	1.0064575
	6 37 46.645	100	.0149	7,617.481	.143	7,617.338	7,572	1.0059876	129	1334	3217	1.0064556
	6 53 44.339	100	.0142	957.694	.013	957.681	952	1.0059673	123	1334	3217	1.0064347
	8 24 05.670	40	.0116	5,421.331	.056	5,421.275	5,389	1.0059891	123	1339	3217	1.0064570
9	19 24 10.390	100	.0025	39,604.720	.108	39,604.612	39,369	1.0059847	123	1354	3213	1.0064537
	21 48 27.835	100	.0018	8,657.445	.002	8,657.443	8,606	1.0059777	121	1358	3210	1.0064486
						(75,252.706)	74,805	(1.0059850)				(1.0064533)
	1 13 23.452	100	.0353									
	0 55 26.211	100	.0275	6,122.759	.370	6,122.389	6,086	1.0059791	+187	1342	+3208	1.0064528
	4 53 34.618	100	.0206	7,088.407	.261	7,088.146	7,046	1.0059817	187	1350	3208	1.0064562
	7 02 38.851	100	.0152	7,744.233	.156	7,744.077	7.698	1.0059857	086	1364	3208	1.0064515
	8 53 22.455	100	.0119	6,643.604	.072	6,643.532	6,604	1.0059860	086	1364	3208	1.0064518
	17 45 22.511	100	.0036	31,920.056	.115	21,919.941	31,730	1.0059862	086	1360	3208	1.0064516
	20 29 21.016	100	.0023	9,838.505	.005	9,838.500	9,780	1.0059816	086	1374	3208	1.0064484
	22 22 17.287	100	.0017	6,776.271	.002	6,776.269	6,736	1.0059782	144	1374	3208	1.0064508
						(76,132.854)	75,680	(1.0059838)				(1.0064515)

KNIFE No. 2.

HEAVY END DOWN.

Date.	Time of transit.	No. of trans.	Arc.	Adopted interval.	Corr. arc.	Corrected interval.	No. of oscillations.	Time of one oscillation.	Rate.	Expansion.	Atmos.	Corrected period.
	h. m. s.			s.	s.	s.		s.				s.
Feb. 13	7 45 16.866	100	.0333									
	9 27 15.677	100	.0254	6,118.811	.332	6,118.479	6,082	1.0059979	+101	+1282	+3181	1.0064543
	13 16 18.979	100	.0055	31,743.302	.453	31,742.849	31,554	1.0059848	101	1394	3139	1.0064482
	20 45 16.149	100	.0035	8,937.170	.011	8,937.159	8,884	1.0059837	97	1400	3102	1.0064436
	22 55 50.777	100	.0024	7,834.628	.004	7,834.624	7,788	1.0059866	97	1410	3081	1.0064454
14	1 2 11.884	100	.0016	7,581.107	.002	7,581.105	7,536	1.0059852	97	1410	3069	1.0064428
					....	(62,214.216)	61,844	(1.0059862)				(1.0064471)
	1 53 23.876	100	.0352									
	3 47 30.930	100	.0259	6,847.054	.393	6,846.661	6,806	1.0059744	+113	+1390	+3179	1.0064424
	5 58 52.015	100	.0177	7,881.085	.232	7,880.853	7,834	1.0059808	+113	1416	3164	1.0064501
	7 55 9.574	100	.0129	6,977.559	.101	6,977.458	6,936	1.0059772	156	1439	3149	1.0064516
	18 14 32.448	100	.0020	37,162.874	.118	37,162.756	36,942	1.0059757	156	1439	3105	1.0064457
	20 47 14.899	100	.0018	9,162.451	.000	9,162.451	9,108	1.0059785	156	1485	3064	1.0064440
						(68,030.179)	67,626	(1.0059766)				(1.0064470)

KNIFE No. 1.

HEAVY END UP.

Feb. 15	2 23 10.551	100	.0343									
	3 44 58.882	100	.0210	4,908.331	.231	4,908.100	4,880	1.0057583	+085	+1426	+7282	1.0066376
	5 50 42.193	100	.0098	7,543.311	.107	7,543.204	7,500	1.0057605	085	1450	7229	1.0066369
	7 55 27.093	100	.0044	7,484.900	.002	7,484.898	7,442	1.0057644	085	1460	7178	1.0066367
					....	(19,936.202)	19,822	(1.0057614)				(1.0066370)
16	20 14 56.362	100	.0340									
	22 15 09.878	100	.0164	7,213.516	.272	7,213.244	7,172	1.0057507	+072	+1461	+7264	1.0066304
	24 00 26.129	100	.0083	6,316.251	.058	6,316.193	6,280	1.0057632	072	1465	7188	1.0066357
	2 03 02.343	100	.0036	7,356.214	.015	7,356.199	7,314	1.0057697	072	1470	7113	1.0066352
						(20,883.636)	20,766	(1.0057611)				(1.0066337)
	2 47 32.998	100	.0345									
	4 48 26.776	100	.0165	7,253.778	.284	7,253.499	7,212	1.0057535	+093	+1451	+7276	1.0066355
	7 11*25.678	100	.0065	8,518.902	.066	8,518.836	8,470	1.0057658	093	1460	7187	1.0066398
	9 6 11.560	100	.0030	6,945.882	.009	6,945.873	6,906	1.0057737	093	1453	7100	1.0066383
						(22,718.203)	22,588	(1.0057643)				(1.0066380)
17	2 23 09.106	100	.0360									
	4 14 07.500	100	.....	6,658.394	.280	6,658.114	6,620	1.0057573	151	1430	+7188	1.0066342
	6 17 09.922	100	.0075	7,382.422	.066	7,382.356	7,340	1.0057705	151	1435	7127	1.0066418
	8 12 37.748	100	.0033	6,927.826	.010	6,927.816	6,888	1.0057806	151	1437	7075	1.0066469
						(20,968.286)	20,848	(1.0057698)				(1.0066411)

*The minute should evidently be 10.

DETAILS OF DETERMINATIONS OF GRAVITY AT EBENSBURGH, CAMBRIA COUNTY, PENNSYLVANIA, IN 1879.

Ebensburgh corrections to chronometer Negus 1589.

DETERMINED FROM STAR OBSERVATIONS AT EBENSBURGH.

Date.	Epoch.	Correc.	Mean epoch of comp.	Correc.
1879.	*h. m.*	*m. s.*	*h. m.*	*m. s.*
Aug. 28	20 40	−0 46.06	18 44	−0 46.49
29	19 30	49.06	18 46	48.99
31	19 57	53.89	19 17	53.83
Sept. 5	19 48	−1 5.33	19 15	5.28
6	21 18	8.01	19 39	7.87
7	20 30	10.19	19 22	10.09
9	21 00	14.87	19 33	14.74
11	20 36	18.97	19 33	18.90
12	19 20	20.06	70 15	20.74
15	19 20	26.60	20 27	26.70
16	19 12	28.50	20 39	28.62
16	21 42	28.72		
17	19 6	30.77	20 43	30.69
17	21 18	30.66		

DETERMINED FROM SIGNALS FROM ALLEGHENY.

Date.	Epoch by 1589.	Correc.	Mean epoch of comp.	Correc.
1879.	*h. m.*	*m. s.*	*h. m.*	*m. s.*
Aug. 28	6 46	−0 45.12	18 44	−0 46.22
29	18 48	48.94	18 46	48.94
30	18 50	51.60	18 52	51.60
Sept. 5	19 12	−1 5.42	19 15	5.42
6	19 23	7.87	19 39	7.89
9	19 36	14.80	19 33	14.80
10	19 34	16.82	19 33	16.82
11	19 43	18.79	19 46	18.80
13	20 19	23.00	20 22	23.00
15	20 26	26.68	20 27	26.68
16	20 33	28.63	20 39	28.64
17	20 39	30.79	20 43	30.80

Chronometer comparisons, Ebensburgh, Pa.

Date.	Epoch by 1589.	Seconds of excess of 1589 over—		
		202.	2490.	380.
		s.	*s.*	*s.*
Aug.	28.29	−42.59	+41.50	+27.00
	.78	4.72	42.40	27.31
	29.28	27.08	43.09	27.59
	.78	49.49	44.03	28.22
	30.28	11.84	44.75	28.70
	.79	34.33	45.62	29.32
	31.30	58.14	46.23	29.64
	.80	19.05	46.89	30.24
Sept.	1.29	41.49	47.29	30.58
	.79	3.63	48.04	31.31
	2.29	25.51	48.58	31.65
	.80	48.01	49.39	32.13
	3.29	9.63	49.92	32.39
	.80	31.08	50.60	32.81
	4.30	53.70	51.02	32.82
	.80	15.81	51.72	33.25
	5.30	37.39	52.27	33.20
	.80	59.51	53.11	33.72
	6.30	21.37	53.86	34.33
	.82	43.66	54.78	35.20
	7.30	4.83	55.47	35.81

Date.	Epoch by 1589.	Seconds of excess of 1589 over—		
		202.	2490.	380.
		s.	*s.*	*s.*
Sept.	.81	−26.65	+56.29	+36.44
	8.31	48.43	56.82	36.77
	.81	9.95	59.67	37.29
	9.31	31.72	58.27	37.69
	.81	53.53	59.07	37.80
	10.31	14.93	59.69	37.74
	.81	36.70	0.45	38.44
	11.32	58.66	1.14	38.93
	.82	20.64	1.95	39.56
	12.32	42.30	2.53	40.01
	.84	5.18	3.24	40.57
	13.33	26.09	3.75	41.04
	.85	48.62	4.37	41.60
	14.33	9.62	4.69	41.88
	.85	32.07	5.39	42.45
	15.33	52.76	5.83	42.84
	.85	15.28	6.47	43.37
	16.33	36.00	6.80	43.73
	.86	59.01	7.48	44.29
	17.34	19.75	8.06	44.75
	.86	42.16	8.70	45.29

Comparison of thermometers, Ebensburgh, Pa., 1879.

SEPTEMBER 29.

Thermometer.	11h 41m	11h 49m				
	M. B., observer.			C. S. P., observer.		
	Forward.	Back.	Mean.	Forward.	Back.	Mean.
	°	°	°	°	°	°
Z	13.93	14.09	14.01	14.15	14.20	14.17½
108	13.90	14.05	13.97½	14.10	14.13	14.11½
K	14.58	14.62	(57.2) 14.60	14.69	14.73	(57.4) 14.71
Kew	13.80	13.80	13.80	13.95	14.00	13.97½
P	13.88	13.90	13.89	14.02	14.04	14.03
Q	13.80	13.85	13.82½	13.96	13.97	13.96½
5	57.6	57.7	57.6½	57.8	57.8	57.8
7	51.3	51.3	51.3	51.4	51.4	51.4
A. C. A	56.8	56.9	56.8½	56.9	56.9	56.9
C. S. P	56.9	56.9	56.9	57.2	57.2	57.2
	11h 46m					

	11h 59m	12h 03m		12h 15m	12h 18m	
	°	°	°	°	°	°
Z	14.36	14.42	14.39	14.73	14.77	14.75
108	14.30	14.38	14.34	14.66	14.71	14.68½
K	14.90	14.96	(57.8) 14.93	15.26	15.29	(58.4) 15.27
Kew	14.20	14.30	14.25	14.65	14.60	14.62
P	14.22	14.25	14.23½	14.61	14.64	14.62
Q	14.18	14.20	14.19	14.62	14.54	14.58
5	58.3	58.3	58.3	58.8	58.8	58.8
7	51.8½	51.8½	51.8	52.5	52.5	52.5
A. C. A	57.3	57.3	57.3	58.0	58.0	58.0
C. S. P	57.5	57.5	57.5	58.2	58.2	58.2
	12h 01m			12h 16½m		

Thermometer.	1h 53m	1h 55m		2h 08m	2h 11m	
	C. S. P., observer.			C. S. P., observer.		
	Forward.	Back.	Mean.	Forward.	Back.	Mean.
	°	°	°	°	°	°
Z	16.64	16.67	16.65½	16.92	16.96	16.94
108	16.71	16.73	16.72	16.87	16.89	16.88
K	17.20	17.19	(62.1) 17.19½	17.44	17.45	(62.4) 17.44½
Kew	16.50	16.45	16.47½	16.73	16.75	16.74
P	16.50	16.52	16.51	16.77	16.80	16.78½
Q	16.56	16.56	16.56	16.74	16.75	16.74½
5	62.4	62.4	62.4	62.9	63.0	62.9½
7	55.9	55.9	55.9	54.9	54.8	54.8½
A. C. A	61.5	61.5	61.5	61.9	62.0	61.9½
C. S. P	61.6	61.6	61.6	62.2	62.2	62.2
	1h 54m			2h 10m		

OCTOBER 1.

	8½			8h 30m	8h 35m	
	H. F., observer.			H. F., observer.		
	°	°	°	°	°	°
Z	17.16	17.15	17.15½	17.08	17.07	17.07½
108	17.00	16.97	16.98½	16.91	16.91	16.91
K	17.74	17.70	(62.6) 17.72	17.62	17.61	62.4 17.61½
Kew	17.0	16.85	16.92½	16.8	16.8	16.8
P	16.97	16.96	16.96½	16.91	16.89	16.90
Q	16.92	16.92	16.92	16.88	16.88	16.88
5	63.45	63.45	63.45	63.4	63.35	63.37
7	56.9	56.85	56.87	56.75	56.75	56.7½
A. C. A	62.4	62.4	62.4	62.35	62.35	62.3½
C. S. P	62.5	62.55	62.5	62.45	62.45	62.4½

Excesses of thermometers over No. 108, Ebensburgh, Pa., 1879.

Thermometer.	September 29.						October 1.		Adopted values.
	M. B. Observer.	C. S. P. Observer.	M. B. Observer.	C. S. P. Observer.	C. S. P. Observer.	C. S. P. Observer.	H. F. Observer.	H. F. Observer.	
	°	°	°	°	°	°	°	°	°
Z	+ .03½	+ .06	+ .05	+ .06½	— .06½	+ .06	+ .17	+ .17	+ .05
K	+ .62½	+ .59½	+ .59	+ .59	+ .47½	+ .56½	+ .74	+ .71	+ .59
Kew	— .17½	— .14	— .09	— .06	— .24½	— .14	— .06	— .1	— .15
P	— .08½	— .08½	— .10½	— .06	— .21	— .09½	— .02	— .01	— .09
Q	— .15	— .15	— .15	— .10½	— .16	— .13½	— .06	— .03	— .15
5	+ .4½	+ .4	+ .5	+ .4	+ .3	+ .5½	+ .9	+ .93	+ .4
7	—5.9	—6.0	—6.0	—5.9	—6.2	—7.5½	—5.7	—5.7	.....
A. C. A	— .3½	— .5	— .5	— .4	— .6	— .4½	— .2	— .1	— .5
C. S. P	— .3	— .2	— .3	— .2	— .5	— .2	.0	.0	— .2

CORRECTION TO 108 (BY BOILING).

[Bar. 28in. 151; att. ther. 73°. 5.]

Time.	Temp.	Remarks.
h. m.	°	
2 37½	97.36	
38	.52	
38½	.62	
39	.67	
39½	.69	Steam.
40	.69	
40½	.69	

Bar = 28in. 151
.112

Bar. at 0°..... 28 .039 = 712mm. 17

True temp..... 98. 19
Corr'd for grav 98. 17
Ther. 108 ..... 97. 69

+. 48 = corr. to 108

[Bar. 28in. 150; att. ther. 76°. 5.]

Time.	Temp.	Remarks.
h. m.	°	
3 12	93. 6	
12½	97. 20	
13	97. 45	
13½	97. 61	
14	97. 70	
14½	97. 70	Steam from bottom.
15	97. 71	
15½	97. 72	
16	97. 72	
16½	97. 72	
17	97. 73	
17½	97. 73	
22	97. 73	

Bar. = 28in. 150
.120

28 .030 = 711mm. 95

True temp..... 98. 18
Corr'd for gravity 98. 16
Ther. 108 ..... 97. 73

+. 43 = corr. to 108

NOTE. Ther. 108 was afterward found to be subject to a very different correction at the boiling point from that which belongs to it at ordinary temperatures.

DECREMENTS OF ARC.

TABLES TO FIND INCLINATION.

Heavy end down, Sept. 6, 1879.				Heavy end up, Sept. 7, 1879.				
ϕ		D.	Adopted.	Tab. No.	T_n	D.	Adopted.	Tab. No.	ϕ
200	10h 30m .7	.....	.....	3.5	10h 31.8	.....	.....	1.4	200
190	34 .3	3.6	3.5	3.6	33.2	1.4	1.4	1.5	190
180	38 .0	3.7	3.7	3.8	34.0	1.7	1.6	1.7	180
170	41 .8	3.8	3.9	4.0	36.6	1.7	1.8	1.9	170
160	46 .0	4.2	4.1	4.2	38.6	2.0	2.0	2.1	160
150	50 .3	4.3	4.3	4.4	40.7	2.1	2.2	2.3	150
140	56 .3	6.0	4.6	4.7	43.0	2.3	2.4	2.5	140
130	61 .2	4.9	4.9	5 2	45.2	2.2	2.6	2.7	130
120	67 .2	6.0	5.4	5.7	48.0	2.8	2.8	3.0	120
110	74 .6	7.4	6.0	6.5	51.2	3.2	3.2	3.3	110
100	81 .5	6.9	7.0	7.7	54.5	3.3	3.4	3.6	100
90	89 .9	8.4	9.2	9.2	57.9	3.4	3.8	4.2	90
80	100 .0	10.1	10.1	11.0	62.5	4.6	4.7	5.1	80
70	.....	.....	12.0	.....	68.0	5.5	5.5	.....	.....

FOR HIGH ARCS.

Heavy end down, Sept. 6, 1879.						Heavy end up, Sept. 7, 1879.				
φ		D.	Adopted.	Tab. No.		T_a	D.	Adopted.	Tab. No.	φ
450	9 46 .0	.....	.....	0.9		10^h 11.5	.....	.....	.....	450
440	9 46 .9	.9	0.9	0.9		12.0	0.5	0.5	0.5	440
430	48 .0	1.1	0.9	0.9		12.5	0.5	0.5	0.5	430
420	49 .0	1.0	1.0	1.0		13.0	0.5	0.5	0.5	420
410	50 .0	1.0	1.0	1.0		13.4	0.4	0.5	0.5	410
400	51 .3	1.3	1.1	1.1		14.0	0.6	0.5	0.5	400
390	52 .6	1.3	1.1	1.1		14.5	0.5	0.5	0.5	390
380	53 .9	1 3	1.2	1.2		15.0	0.5	0.5	0.5	380
370	55 .1	1.2	1.2	1.2		15.6	0.6	0.6	0.6	370
360	56 .3	1.2	1.3	1.3		16.3	0.7	0.6	0.6	360
350	57 .8	1.5	1.4	1.4		17.0	0.7	0.7	0.7	350
340	59 .2	1.4	1.4	1.4		17.6	0.6	0.7	0.7	340
330	10 00 .8	1.6	1.5	1.5		18.2	0.6	0.7	0.7	330
320	02 .2	1.4	1.6	1.6		19.0	0.8	0.8	0.8	320
310	04 .1	1.9	1.7	1.7		19.8	0.8	0.8	0.8	310
300	06 .0	1.9	1.8	1.8		20.5	0.7	0.8	0.8	300
290	07 .7	1.7	1.9	1.9		21.3	0.8	0.9	0.9	290
280	09 .7	2.0	2.0	2.0		22.2	0.9	0.9	0.9	280
270	11 .9	2.2	2.1	2.1		23.2	1.0	1.0	1.0	270
260	14 .1	2.2	2.2	2.3		24.2	1.0	1.0	1.0	260
250	16 .5	2.4	2.4	2.5		25.4	1.2	1.1	1.1	250
240	18 .9	2.4	2.6	2.6		26.5	1.1	1.1	1.1	240
230	21 .5	2.6	2.7	2.8		27.7	1.2	1.2	1.2	230
220	24 .4	2.9	2.9	3.1		28.9	1.2	1.2	1.2	220
210	27 .5	3.1	3.3	3.4		30.2	1.3	1.3	1.3	210

DETERMINATION OF INCLINATION.

	September 5, 1879.				September 6, 1879.				September 7, 1879.				September 8, 1879.			
φ	Heavy end down.		Heavy end up.		Heavy end up.		Heavy end down.		Heavy end down.		Heavy end up.		Heavy end up.		Heavy end down.	
	dt.	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*	*dt.*	*dφ.*
190	2.20	+3.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
180	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
170	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.05	−1.3
160	2.90	+3.4	.....	.....	.....	.....	.....	.....	1.90	−2.3	.....	.....	.....	.....	1.20	−1.4
150	3.00	+3.4	.60	+1.3	.55	+1.2	3.20	+3.6	1.35	−1.5	.85	+1.8	.....	.....	1.25	−1.4
140	3.25	+3.4	.60	+1.2	.65	+1.3	2.65	+2.8	1.65	−1.8	.95	+1.9	.50	+1.0	1.35	−1.4
130	.....	.....	.80	+1.5	.80	+1.5	3.50	+3.4	2.10	−2.0	1.00	+1.8	.40	+ .7	1.65	−1.6
120	.....	.....	.70	+1.2	.....	.....	3.80	+3.3	2.65	−2.3	.....	.....	.80	+1.3	1.75	−1.4
110	4.20	+3.2	.....	.....	.70	+1.1	4.10	+3.1	2.50	−1.9	1.35	+2.0	.45	+ .7	2.65	−2.0
100	.....	.....	.....	.....	.70	+1.0	4.75	+3.1	3.50	−2.3	1.45	+2.0	.55	+ .8	1.75	−1.1
90	.....	.....	1.35	+1.5	.....	.....	.....	.....	3.00	−1.6	1.75	+2.1	1.10	+1.3	2.40	−1.3
80	.....	.....	1.10	+1.1	1.50	.....	.....	.....	.....	.....	2.10	+2.1	1.00	+1.0	.....	.....
Mean	..	+3.3	.....	+1.3	.....	+1.2	.....	+3.2	.....	−1.8	.....	+2.0	.....	+1.0	.....	−1.4

DETERMINATION OF INCLINATION—Continued.

	September 14, 1879.				September 15, 1879.				September 16, 1879.				September 17, 1879.			
	Heavy end down.		Heavy end up.		Heavy end up.		Heavy end down.		Heavy end down.		Heavy end up.		Heavy end up.		Heavy end down.	
ϕ	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$	$dt.$	$d\phi.$
190	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
180	+.+	.. ....	.....	.....	.....	.....	.70	+0.9	.....	.....	.....	.....	.....	.....	.....	.....
170	1.15	+1.4	.....	.....	.....	.....	.95	+1.1	.....	.....	.....	.....	.....	.....	.....	.....
160	1.30	+1.5	.....	.....	.....	.....	.90	+1.1	1.45	+1.7	.....	.....	.....	.....	1.50	−1.8
150	1.40	+1.6	.....	.....	.95	−2.1	1.60	+1.8	1.25	+1.4	.....	.....	.20	+ .0	1.80	−2.0
140	1.70	+1.8	1.05	−2.1	1.10	−2.2	.....	.....	1.75	+1.9	.20	+ .0	.....	.....	1.90	−2.0
130	.....	.....	1.55	−2.9	.....	.....	1.00	+1.0	.....	.....	.15	+ .0	.....	.....	.....	.....
120	.....	... .	1.40	−2.3	1.35	−2.1	.....	.....	2.30	+2.0	.....	.....	.....	.....	.....	.....
110	1.70	+1.3	1.85	−2.8	1.60	−2.4	.75	+0.6	.....	.....	.....	.....	.....	.....	....	.....
100	2.05	+1.3	2.15	−3.0	1.80	−2.5	.....	.....	2.45	+1.6	.....	.....	.35	+ .5	.....	.....
90	2.65	+1.4	.....	.. ....	.....	.....	2 25	+1.2	.....	.....	.75	+ .9	.75	+ .9	3.65	−2.0
80	.....	.....	2.60	−2.6	3.80	−3.7	.....	.....	.....	.....	.75	+ .7	.70	+ .7	.....	.....
Mean	.....	+1.5	.....	−2.6	.....	−2.5	.....	+1.1	.....	+1.7	.....	+0.4	.....	+0.5	.....	−2.0

dt is taken to nearest .05 minutes.
$d\phi$ + indicates that time observed on L is less.
The rule is, multiply the tabular numbers by 10; divide this into $\frac{dt}{2}$; this gives inclination.

PENDULUM AT EBENSBURGH, PA., 1879.

Corrected times of reaching different amplitudes.

HEAVY END UP.

Arc.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 14.	Sept. 15.	Sept. 16.	Sept. 17.
	m. s.	*m. s.*	*m. s.*	*m. s.*	*m. s.*	*m. s.*	*m. s.*	*m. s.*
.0520	.....	.....	.....	.....	26 04	.....	.....	25 58
510	.....	.....	.....	.....	26 30	.....	.....	26 22
500	.....	.....	.....	.....	26 49	.....	.....	26 44
490	.....	.....	10 02	.....	27 10	.....	.....	27 03
480	.....	.....	10 24	.....	27 36	.....	11 22	27 24
470	.....	.....	10 48	.....	.....	.....	11 46	.....
460	.....	.....	11 13	.....	28 20	20 51	12 08	.....
450	16 54	.....	11 38	10 55	28 48	21 14	12 35	.....
440	17 25	.....	12 07	11 20	29 14	.....	13 02	28 57
430	17 57	.....	12 33	11 46	29 33	22 02	.....	29 25
420	.....	.....	13 00	12 13	.....	22 29	13 58	29 55
410	18 57	39 12	13 32	12 39	.....	22 59	.....	30 19
400	19 27	39 44	14 06	13 07	31 08	23 26	15 00	30 51
390	19 54	40 18	14 34	13 34	.....	23 53	15 30	.....
380	.....	.....	.....	.....	.....	.....	.....	.....
370	.....	41 22	.....	.....	.....	24 49	.....	.....
360	.....	.....	.....	.....	.....	25 14	.....	.....
350	.....	.....	.....	.....	.....	.....	.....	.....
340	.....	.....	.....	.....	.....	.....	.....	.....
330	.....	.....	.....	.....	.....	.....	.....	.....
320	.....	.....	.....	.....	.....	.....	.....	.....
310	.....	.....	.....	.....	.....	.....	.....	.....
200	.....	.....	.....	.....	.....	.....	21 34	.....
290	.....	.....	.....	.....	.....	.....	.....	37 54
280	27 54	.....	22 28	.....	39 36	.....	23 12	38 46
270	28 46	.....	23 24	20 56	40 32	.....	24 12	.....
260	29 43	.....	24 27	.....	41 35	.....	25 19	40 34
250	30 48	50 53	25 41	22 37	42 39	.....	26 21	41 41
240	31 51	52 07	26 42	.....	43 39	.....	.....	42 46
230	33 12	53 11	27 53	24 20	45 03	.....	.....	43 50
220	34 26	54 25	29 11	25 13	46 29	35 49	.....	.....
210	35 44	55 54	30 27	26 10	47 42	36 48	31 23	.....
200	.....	57 10	31 57	.....	49 20	38 05	32 53	.....
190	38 42	58 47	33 36	28 40	50 49	39 20	34 26	49 03
180	40 22	60 25	35 12	30 11	52 27	40 39	36 09	50 31
170	.....	.....	.....	.....	.....	.....	.....	.....
160	.....	.....	.....	.....	.....	.....	.....	.....
150	46 07	66 09	41 02	35 44	58 14	45 34	42 05	56 10
140	48 38	68 37	43 30	37 18	60 38	47 35	44 16	58 22
130	51 08	71 08	45 45	39 04	63 17	50 01	46 53	60 54
120	.....	74 00	48 22	40 57	66 10	52 49	.....	.....
110	.....	77 11	51 50	42 45	69 09	55 48	.....	.....
100	.....	80 35	55 10	45 20	72 41	59 04	.....	69 28
90	64 27	84 28	58 40	48 00	76 24	63 03	60 20	73 01
80	68 56	89 11	63 35	51 30	81 02	67 26	64 59	77 32

PENDULUM AT EBENSBURGH, PA., 1879—Continued.

Corrected times of reaching different amplitudes—Continued.

HEAVY END DOWN.

Arc.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 14.	Sept. 15.	Sept. 16.	Sept. 17.
	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
.0520								33 09
510								33 56
500								34 42
490				33 50		28 48	6 10	35 26
480				34 44		29 33	6 58	36 21
470	8 37			35 30		30 22	7 51	37 10
460	9 23			36 17		31 18	8 47	38 00
450	10 24	46 18				32 18		38 59
440	11 22	47 14	2 54	38 00		33 13	10 40	
430	12 16	48 17	3 53	39 00			11 37	40 57
420	13 19	49 19	4 57	39 51			12 46	
410			6 06	40 36	41 50			
400		51 45	7 16	41 39	42 46			
390		52 50			43 55			
380					45 00			
370						41 12		47 58
360						42 33		49 24
350						43 57	21 12	50 48
340	23 37			48 56		45 12		52 05
330	25 12		17 08	50 12		46 43	23 49	
320		62 51	18 38	51 43		48 34		
310		64 38	20 09				26 34	
300	30 36	66 37	22 28	54 41			28 08	
290	32 15	68 20	24 05	56 38		53 50	29 50	
280			26 03	58 36	59 01	55 38		
270	36 35				60 48	57 43		
260		74 52	30 35	62 52	62 39			
250	41 10	77 17	32 47	64 40			37 09	
240	43 34	79 46	35 20	67 05	66 34		39 17	70 07
230	46 21	82 31	37 56	69 43			41 49	73 31
220			40 37	72 51	70 32	69 48	44 16	75 21
210	52 25	88 35	43 56	75 21	73 07	72 35		78 12
200	55 24	91 48	47 18	78 39	75 32	75 43		81 07
190	59 05	95 24	51 03	81 32	78 14		53 48	
180	62 56					82 59		
170	66 57	103 04		88 56	83 37	86 50	61 14	
160	71 12	107 28	62 53	92 45	87 27	90 56	65 38	94 54
150	75 49	112 02	67 52	97 12	91 17	95 48	70 22	99 40
140	80 54	117 47	72 53	101 44	96 03		75 23	104 36
130	86 30	122 56	78 42	107 19		106 30		
120		129 12	84 50	113 10	107 58	112 52	87 32	
110	99 55	136 46	91 53	120 19	114 02	119 50		
100	106 58	143 52	99 40	126 53	119 52		102 23	130 22
90	115 50	152 51	108 10	134 12	128 03	136 07		138 23
80								

HEAVY END DOWN.

Date.	190.	180.	170.	160.	150.	140.	130.	120.	100.	90.	80.
1879.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
Sept. 1							*47	6 47			
5	−40 50			−28 43	−24 06	−19 01					
6					24 44	18 59	−13 50	−7 34	+7 00		
7				20 00	24 01	19 00	13 11	7 03	7 47	+16 17	
8			−31 23	27 34	23 07	18 35	13 00	7 09	6 34	13 53	
14			30 25	26 35	22 45	17 59			5 50	14 01	
15		−36 51	33 00	28 54	24 02		13 20			16 17	
16				28 31	(*)	18 46		6 37	8 14		
17				28 33	(*)	18 51				14 56	
Means	−40 50	−36 51	−31 36	−28 16	−23 47	−18 44	−13 20	−6 02	+7 06	+15 05	

(*) Rejected.

HEAVY END UP.

Date.	190.	180.	170.	160.	150.	140.	130.	120.	100.	90.	80.
1879.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
Sept. 1											
5					(*)	−8 33	−6 03	−3 17		+7 16	+11 45
6					−12 02	8 34	06 03		+3 24		12 00
7					10 48	8 20	6 05		3 20	6 50	11 45
8						5 27	3 41	1 48	2 35	5 15	18 45
14						8 31	5 52	2 59	3 32		11 53
15					10 14	8 13		2 59	3 16		11 38
16						(*)	5 48			7 29	12 18
17					(*)				2 06	5 47	10 18
Means					−11 01	−8 26	−5 58	−3 05	+3 08	+6 50	+11 40

* Rejected.

U. S. C. S. PENDULUM AT EBENSBURGH, PA., 1879.

CENTER OF MASS.

Date.	Knife at heavy end and figure for—	Pos. of name.	Heavy end. Reading in middle.	Heavy end. Reading at end.	Light end. Reading in middle.	Light end. Reading at end.	h_d+x	h_d-x	h_d-h_s	Concluded. h_d-h_s	Remarks.
1879.											
Sept. 6	7–8	U	17036	.00946	56068	.00633	16090	55435	39345	.....	Apparatus out of level. Reject.
		D	36	944	068	639	092	426	334	39340	
6	.....	U	17053	.01006	.....	.00651	16047	55417	370	.....	
		D	.....	004	56068	651½	049	406½	357½	364	
6	3–4	U	17053	.01003	56057	.00650½	16050	55406½	356½	.....	Mean value 39351
	3	D	.....	003	.....	654	050	403	353	355	Corr ..... +14
16	3–4	U	17019	.00964½	56056	.00650½	16054½	55405½	351	.....	39365
		D	20	964½	.....	653½	055½	402½	347	349	
16	7–8	U	17019	.00969	56047	.00639	16050	55408	358	.....	
	7	D	19	954½	046	642	061½	404	339½	349	

LENGTH.

Date.	Pos. of heavy end and name.	Ther. Q.	Ther. K.	Q−K +.74	Above. Stand.	Above. Pend.	Above. P−st.	Below. Stand.	Below. Pend.	Below. P−st.	Uncor'd diff.	Corr. for diff. T.	Corr'd diff.	Means.	
1879.		*Pend.*	*Stand.*												
Sept. 10	Down.	15°.18	15°.88	+.04	1598	2190	+592	1901	2283	+382	+210	− 7	+203	.....	
	For'd.	15 .30	15 .98	+.06	1589	2192	+603	1921	2327	+406	+197	−11	186	+194½	
11	.....	15 .06	15 .65	+.15	1843	1918	+075	2157	2018	−139	+214	−28	186	.....	
	.....	15 .10	15 .77	+.07	1826	1878	+ 52	2160	2014	−146	+198	−13	185	185½	
12	.....	16 .00	16 .81	−.07	1751	1823	+ 72	2164	2066	− 98	+170	+13	183	.....	
	.....	16 .03	16 .82	−.05	1757	1855	+ 98	2165	2087	− 78	+176	+ 9	185	184	
13	.....	16 .69	17 .64	−.21	1756	2004	+248	2138	2224	+ 86	+162	+39	201	.....	
	.....	16 .78	17 .74	−.22	1758	1983	+225	2152	2228	+ 76	+149	+46	189	195	
		Stand.	*Pend.*												
23	.....	16 .13	16 .81	−.06	2073	2421	+348	1961	2124	+163	+185	+11	+196	.....	
	.....	16 .26	16 .88	−.12	2069	2420	351	1949	2127	+178	173	+22	195	195½	
23	.....	16 .30	16 .98	−. 6	2028	2113	85	1933	1823	−110	195	+11	206	.....	
	.....	16 .53	17 .21	−. 6	2004	2101	97	1921	1829	− 92	189	+11	200	203	
24	.....	16 .21	16 .71	−.24	2039	2093	54	1962	1836	−126	180	+44	224	.....	
	.....	16 .29	16 .77	−.26	2023	2074	51	1958	1850	−108	159	+48	207	215½	½ weight.
24	.....	16 .35	16 .83	−.26	2024	2065	41	1963	1842	−121	162	+48	200	.....	
	.....	16 .38	16 .83	−.29	2013	2065	52	1966	1844	−122	174	+53	227	213½	
25	.....	14 .10	14 .81	−. 3	2107	2191	84	1980	1903	− 77	161	+ 6	167	.....	
	.....	14 .15	14 .85	−. 4	2110	2184	74	1995	1904	− 91	165	+ 7	172	169½	
25	.....	14 .19	14 .90	− 3	2032	2163	131	1937	1897	− 40	171	+ 6	177	.....	
	.....	14 .25	14 .94	−. 5	2040	2169	129	1935	1896	− 39	168	+ 9	177	177	

Pend − st. = ... + 19.2 μ
St. − Met. = ... +261.1
Pend − Met. = ... +280.3

Length of Pend..... = 1.0002803 m.

Final mean = ... + 19.2 μ

PERIODS OF OSCILLATION.

Heavy end down.

KNIFE 3–4.

Date	Time of trans.	Interval.	Corr. for arc.	Corrected interval.	No. osc.	Time 1 oscil.	Rate.	Press.	Temp.	Period corrected.
1879.	*h. m. s.*	*s.*	*s.*	*s.*						
Sept. 5	13 19 51.000									
	14 04 56.742	2705.742	.144	2705.598	2688	1.0065468	−267	+207	−232	1.0065176
	56 37.968	3101.226	.033	3101.193	3081	5541				5249
		5806.968	.177	(5806.791)	5769	(1.0065507)				(1.0065215)
6	9 59 37.970									
	10 44 54.794	2716.824	.100	2716.724	2699	1.0065669	−397	+197	−147	1.0065322
	11 37 43.409	3168.615	.033	3168.582	3148	5382				5035
		(5885.439)	.133	(5885.306)	5847	(1.0065515)				(1.0065168)

KNIVES INTERCHANGED. KNIFE 7–8.

Sept. 7	9 13 11.861									
	59 25.049	2773.188	.109	2773.079	2755	1.0065622	−267	+204	−184	1.0065375
	10 55 15.942	3350.893	.032	3350.861	3329	5669				5422
		6124.081		(6123.940)	6084	(1.0065648)				(1.0065401)
8	9 44 47.050									
	10 25 46.178	2459.128	.106	2459.022	2443	1.0065581	−287	+204	−120	1.0065378
	11 19 4.012	3197.834	.032	3197.802	3177	5473				5270
				(5656.824	5620	(1.0065522)				(1.0065319)
14	9 52 23.855									
	10 21 17.198	1733.343	.068	1733.275	1722	1.0065477	−248	+173	− 36	1.0065366
	11 14 41.046	3203.848	.022	3203.826	3183	5429				5318
	16 47.871	126.825	.000	126.825	126	5476				5365
				(5063.926)	5031	(1.0065447)				(1.0065336)
15	10 36 48.899									
	11 23 30.263	2801.364	.140	2801.224	2783	1.0065483	−235	+182	− 36	1.0065394
	12 21 37.961	3487.698	.037	3487.661	3465	5400				5311
				(6288.885)	6248	(1.0065437)				(1.0065348)

KNIVES INTERCHANGED. KNIFE 3–4.

Sept. 16	14 17 48.943									
	56 20.013	2311.070	.106	2310.964	2296	1.0065175	−227	+213	− 55	1.0065106
	15 57 36.955	3679.942	.039	3679.903	3656	5379				5310
				(5990.867)	5952	(1.0065301)				(1.0065232)
17	9 44 1.946									
	10 27 28.964	2607.018	.130	2606.888	2590	1.0065205	−231	+199	− 28	1.0065145
	11 28 58.949	3689.985	.036	3689.949	3666	5328				5268
				(6296.837)	6256	(1.0065276)				(1.0065216)

Heavy end up.

KNIFE 7–8.

Date.	Time of trans.	Interval.	Corr. for arc.	Corrected interval.	No. osc.	Time, 1 oscil.	Rate.	Press.	Temp.	Period corrected.
1879.	*h. m. s.*	*s.*	*s.*	*s.*						
Sept. 5	15 22 52.053									
	43 11.040	1218.987	.046	1218.941	1211	1.0065575	−267	+473	−225	1.0065556
	16 13 36.944	1825.904	.016	1825.888	1814	65535	.....	.....	.....	5516
				(3044.829)	3025	(65550)	.....	.....	.....	(1.0065531)
6	8 47 25.914									
	9 03 27.202	961.288	.030	961.258	955	1.0065530	−397	+447	−122	1 0065458
	33 29.915	1802.713	.014	1802.699	1791	5321	.....	.....	.....	5249
				(2763.957)	2746	1.0065393	.....	.....	.....	(1.0065321)

KNIVES INTERCHANGED. KNIFE 3–4.

Sept. 7	11 19 01.925									
	37 16.077	1094.152	.039	1094.113	1087	1.0065437	−267	+470	−191	1.0065449
	12 07 41.026	1824.949	.016	1824.933	1813	5819	.....	.....	.....	5831
				(2919.046)	2900	(1.0065675)	.....	.....	.....	(1.0065687)
8	8 17 49.946									
	33 18.944	928.998	.030	928.968	923	1.0064659	−287	+467	−114	1.0064725
	56 39.986	1401.042	.010	1401.032	1392	4884	.....	.....	.....	4950
				(2330.000)	2315	4795	.....	.....	.....	(1.0064861)
14	11 38 11.823									
	56 45.105	1113.282	.044	1113.238	1106	1.0065443	−248	+404	− 63	1.0065536
	12 24 56.120	1691.015	.013	1691.002	1680	5488	.....	.....	.....	5581
				2804.240	2786	(1.0065470)	.....	.....	.....	(1.0065563)
15	9 32 10.946*									
	44 27.710	736.764	.021	736.743	732	1.0064795	−235	+411	− 09	†1.0064962
	10 13 18.955	1731.245	.013	1731.232	1720	5303	.....	.....	.....	5470
				(2467.975)	2452	(1.0065161)	.....	.....	.....	(1.0065328)

KNIVES INTERCHANGED. KNIFE 7–8.

Sept. 16	16 19 30.942									
	38 17.277	1126.335	.042	1126.293	1119	1.0065175	−227	+495	− 83	1.0065360
	17 08 24.044	1806.727	.017	1806.710	1795	5238	.....	.....	.....	5423
				(2933.003)	2914	(1.0065213)	.....	.....	.....	(1.0065398)
17	8 35 06.862									
	53 24.964	1098.102	.041	1098.061	1091	1.0064722	−231	+451	− 18	1.0064924
	9 24 25.002	1860.038	.015	1860.023	1848	5059	.....	.....	.....	5261
				(2958.084)	2939	(1.0064934)	.....	.....	.....	(1.0065136)

* The only transits of this swing in which artificial light was used. † Rejected.

DETAILS OF DETERMINATIONS OF GRAVITY AT YORK, PA., IN 1880.

The following tables show the details of the work:

YORK TIME OBSERVATIONS, 1880.

MARCH 5.

Azimuth	+13.20
Lev. W. and E.	+.26 + .30
Collim.	— 1.10
Prob. error	± .37

Star.	δ	Res.
	°	s.
α Urs. maj ..	+78	.00
δ Leo	+21	— .01
λ Dra	+70	+1.84
β Leo	+15	.00
γ Urs. maj ..	+54	—1.25

MARCH 8.

Azimuth	—15.08
Lev. W. and E.	—.03 ± .01
Collim.	+ 1.53
Prob. error	± .04

Star.	δ	Res.
	°	s.
ε Can. maj ..	—29	+.07
δ Can. maj ..	—26	—.09
α Gem	+32	.00
β Gem	+28	.00

MARCH 17, I.

Azimuth	— 2.88
Lev. W. and E.	+.45 +.53
Collim.	+ 1.93
Prob. error	± .06

Star.	δ	Res.
	°	s.
ε Can. maj ..	—29	.00
δ Can. maj ..	—26	—.04
δ Gem	+22	.00
Pvii 67.....	+68	—.17
α Can.....	+ 6	—.17
β Gem	+28	+.29

MARCH 17, II.

Azimuth	4.41 & 3.76
Lev. W. and E.	+.47 + .60
Collim.	2.26
Prob. error	± .11

Star.	δ	Res.
	°	s.
9 H. Dra	+ 76	+.02
ρ Leo	+ 10	+.08
B. Ceph	+104	Rej.
l Leon	+ 11	—.08
α Urs. maj ..	+ 62	+.35
δ Crat	— 14	—.31
τ Leo	+ 4	+.34
λ Dra	+ 70	—.60

MARCH 20.

Azimuth	—3.11
Lev. W. and E.	+.41 + .48
Collim.	+1.94
Prob. error	± .18

Star.	δ	Res.
	°	s.
η Virg	0	Rej.
β Corv.....	— 23	+.12
21 Cass	+106	Rej.
32 H. Cam ..	+ 84	+.92
12 Cam. ven.	+ 39	—.88
∂ Virg	— 5	+.34
α Urs. min ..	+ 91	Rej.
α Virg	— 10	+.21

MARCH 21.

Azimuth	—.04
Lev. W. and E.	+.30 +.45
Collim.	+.55
Prob. error	±.15

Star.	δ	Res.
	°	s.
κ Ceph	+77	—.04
Gr. 3241 .	+72	+.85
ε Hyd.....	+ 6	—.19
i Urs. maj...	+49	+.20
12 Y. C. 79...	+80	—.59
1 H. Dra	+82	+.82
α Hyd	— 8	+.35
δ Ur. maj	+70	—.55

MARCH 22.

Azimuth { W.	+.16
Azimuth { E.	+.33
Lev. W. and E.	+.31 +.42
Collim.	+.28
Prob. error	±.05

Star.	δ	Res.
	°	s.
51 H. Cep ..	+87	+.19
ε Can. maj ..	—29	—.01
δ Can. maj ..	—26	+.08
δ Gem	+22	—.07
Pvii 67 .	+68	—.12
α Gem	+32	+.22
α Can. maj ..	6	—.17

MARCH 23.

Azimuth { W.	—.29
Azimuth { E.	—1.11
Lev. W. and E.	+.39 + .33
Collim.	+ .62
Prob. error	± .21

Star.	δ	Res.
	°	s.
σ^2 Urs. maj .	+68	.00
Canc.....	+11	+ .01
1 H. Dra ...	+82	+1.30
α Hyd	— 8	+ .36
d Ur. min ..	+70	— .27
∂ Urs. maj ..	+52	— .77

MARCH 24.

Azimuth { W.	—1.15
Azimuth { E.	— .74
Lev. W. and E.	+.30 + .33
Collim.	+ .56
Prob. error	± .11

Star.	δ	Res.
	°	
σ Ur. maj ...	+68	—.01
κ Cane	+11	.00
1 H Dra	+82	—.58
ε Hyd	— 8	+.02
d Ur. maj ...	+70	+.65
∂ Ur. maj ...	+52	—.23

MARCH 25.

Azimuth { W.	—.44
Azimuth { E.	—.83
Lev. W. and E.	+.20 +.27
Collim.	+.74
Prob. error	±.07

Star.	δ	Res.
	°	
δ Gem	+22	+.14
Pvii 67.....	+69	—.27
α Gem	+32	Rej.
φ Gem	+27	—.23
3 H. Ur. maj.	+69	+.20
15 Arg.....	—24	—.05

MARCH 30.

Azimuth { W.	—.07
Azimuth { E.	+1.64
Lev. W. and E.	+.22 —.32
Collim.	+1.28
Prob. error	± .07

Star.	δ	Res.
	°	
δ Gem	+22	+.78
Pvii 67.....	—27	+.02
α Gem	+32	—.20
α Can. min ..	+ 6	—.01
β Gem	+28	—.15
φ Gem	+27	+.15

MARCH 31.

Azimuth	— 49
Lev. W. and E.	+.25 +.30
Collim.	+.90
Prob. error	±.08

Star.	δ	Res.
	°	
α Can. min ..	+ 6	—.21
β Gem	+ 28	+.27
φ Gem	+ 27	—.07
3 Urs. maj ..	+ 69	—.10
15 Arg.....	— 24	+.05
κ Ceph.....	+103	Rej.

YORK TIME OBSERVATIONS, 1880—Continued.

April 1.

Azimuth	−.37
Lev. W. and E.	+.26 +.37
Collim.	+.55
Prob. error	±.06

Star.	δ	Res.
	°	
β Corv	− 23	+ .14
21 Cass	+106	− .02
32 H. Cam	+ 84	− .44
12² Can. ven.	+ 39	Rej.
ϑ Virgi	− 5	+ .10
α Ur. min	+ 91	−1.70
α Virg	− 11	− .20

April 3.

Azimuth	−.63
Lev. W. and E.	+.27 +.26
Collim.	+.56
Prob. error	±.04

Star.	δ	Res.
	°	
γ Ceph	+77	Rej.
β Leo	+15	−.01
γ Urs. maj	+54	+.02
o Virg	+ 9	+.13
4 H. Dra	+78	−.04
η Virgi	0	−.11

April 4.

Azimuth	−.74
Lev. W. and E.	+.23 +.28
Collim.	+.72
Prob. error	±.08

Star.	δ	Res.
	°	
α Ur. maj	+ 62	−.13
δ Leo	+ 21	+.28
δ Crat	− 14	−.25
τ Leon	+ 4	+.15
λ Dra	+ 70	−.23
ν Leon	0	−.02
α Ceph	+103	Rej.

April 5.

Azimuth	W. + 1.95 / E. + 5.14
Lev. W. and E.	+16 + .21
Collim.	−12.25
Prob. error	±.23

Star.	δ	Res.
	°	
β Leon	+ 15	00
γ Ur. maj	+ 54	00
4 H. Dra	+ 78	−.18
η Virgi	0	+.48
β Corv	− 23	−.47
21 Cass	+106	Rej.

April 6.

Azimuth	W. +1.87 / E. +2.14
Lev. W. and E.	+.14 +.15
Collim.	−6.72
Prob. error	± .25

Star.	δ	Res.
	°	s.
γ Ur. maj	+ 54	Rej.
o Virg	+ 9	−.38
4 H. Dra	+ 78	Rej.
η Virg	0	+.57
β Corv	− 23	+.33
21 Cass	+106	+.62
32 Cam	+ 84	+.84

April 7.

Azimuth	+1.55
Lev. W. and E.	+.05 + .14
Collim.	−5.61
Prob. error	± .08

Star.	δ	Res.
	°	s.
γ Ur. maj	+ 54	+.18
o Virg	+ 9	−.21
4 H. Dra	+ 78	−.08
η Virg	0	−.05
β Corv	− 23	+.19
21 Cass	+106	+.09
	+ 84	

April 8.

Azimuth	W. + .88 / E. +1.06
Lev. W. and E.	+.03 + .04
Collim.	−5.44
Prob. error	+ .04

Star.	δ	Res.
	°	s.
λ Dra	+ 69	−.13
ν Leon	0	+.15
γ Ceph	+103	−.26
β Leon	+ 15	−.11
γ Ur. maj	+ 54	−.04
o Virgi	+ 9	+.03
4 H. Dra	+ 78	+.06

April 17.

Azimuth	W. + .97 / E. +1.51
Lev. W. and E.	+.08 + .10
Collim.	−5.33
Prob. error	± .04

Star.	δ	Res.
	°	s.
ν Leon	0	−.04
γ Ceph	+103	+.15
β Leon	+ 15	−.02
γ Ur. maj	+ 54	+.19
o Virg	+ 9	+.11
4 H. Dra	+ 78	−.01
η Virgi	0	−.16

April 18.

Azimuth	W. + .49 / E. + .95
Lev. W. and E.	+.04 + 04
Collim.	−5.18
Prob. error	± .04

Star.	δ	Res.
	°	s.
ϑ Virg	− 5	+.11
α Virg	−10	−.13
ζ Virg	0	+.01
η Ur. maj	+50	.00
η Bootis	+19	+.13
α Drac	+65	.00
α Bootis	+20	−.14

April 20.

Azimuth	+1.18
Lev. W. and E.	+.04 + .05
Collim.	−5.12
Prob. error	± .04

Star.	δ	Res.
	°	s.
1 H. Dra	+82	Rej.
α Hyd	− 8	−.01
d Ur. maj	+70	−.04
ϑ Ur. maj	+52	+.07
ε Leon	+24	−.14
μ Leon	+27	+.14
α Leon	+13	.00

April 21.

Azimuth	+1.04
Lev. W. and E.	+.03 + .01
Collim.	−4.82
Prob. error	± .11

Star.	δ	Res.
	°	s.
21 Cass	+106	Rej.
32 H. Cam	+ 84	+.04
ζ Virg	− 5	+.01
η Urs. maj	+ 50	−.40
η Bootis	+ 19	+.08
α Dra	+ 65	+.29

April 22.

Azimuth	+ .73
Lev. W. and E.	.00 + .02
Collim.	−4.91
Prob. error	± .11

Star.	δ	Res.
	°	s.
σ² Ur. maj	+68	+.03
κ Canc	+11	+.03
1 H. Dra	+82	+.86
α Hyd	− 8	+.24
d Ur. maj	+70	−.05
ϑ Urs. maj	+52	−.45

YORK TIME OBSERVATIONS, 1880—Continued.

April 26.

Azimuth	W. + .60 / E. + .31
Lev. W. and E.	−.02 − .03
Collim.	−1.16
Prob. error	± .08

Star.	δ	Res.
	°	
50 Cass	+108	−.14
α Dra	+ 65	−.50
ε Bootis	+ 20	+.25
ϑ Bootis	+ 52	+.11
5 Ur. min	+ 76	+.29
ε Bootis	+ 28	+.01
β Ura. min	+ 75	−.34

April 27.

Azimuth	W. + .23 / E. − .12
Lev. W. and E.	−.09 − .03
Collim.	− .16
Prob. error	± .08

Star.	δ	Res.
	°	
η Bootis	+ 19	−.07
50 Cass	+108	Rej.
α Dra	+ 65	−.01
α Bootis	+ 20	+.07
ϑ Bootis	+ 52	−.22
5 Ur. min	+ 76	+.16
ε Bootis	+ 28	+.12

April 28.

Azimuth	W. − .73 / E. − .41
Lev. W. and E.	−.12 − .04
Collim.	− .01
Prob. error	± .07

Star.	δ	Res.
	°	
α Leon	+ 13	−.16
32 Ur. mag	+ 66	−.01
γ¹ Leon	+ 20	+.17
9 H. Dra	+ 76	+.01
φ Leon	+ 10	+.13
226 Ceph	+104	Rej.
l Leon	+ 11	−.15

May 3, I.

Azimuth	W. − .53 / E. + .36
Lev. W. and E.	−.04 + .09
Collim.	+ .32
Prob. error	± .10

Star.	δ	Res.
	°	
32 Ur. maj	+ 66	+.11
β Leon	+ 10	+.12
226 Cep	+104	+.17
l Leon	+ 11	−.12
α Ur. maj	+ 62	−.18
δ Leon	+ 21	+.41
δ Crat	− 14	−.31

May 3, II.

Azimuth	W. − .66 / E + .07
Lev. W. and E.	+.04 + .12
Collim.	− .13
Prob. error	± .05

Star.	δ	Res.
	°	
ξ Leon	+ 3	Rej.
χ Dra	+ 70	.00
γ Ceph	+103	Rej.
β Leon	+ 15	.00
γ Ur. maj	+ 54	−.13
ο Virgi	+ 9	+.06
4 H. Dra	+ 78	+.17

May 4.

Azimuth	W. − .34 / E. − .11
Lev. W. and E.	.00 + .08
Collim.	− .01
Prob. error	± .09

Star.	δ	Res.
	°	
η Ur. mag	+ 50	−.04
η Bootis	+ 19	+.02
50 Cass	+108	Rej.
α Dra	+ 65	+.04
α Bootis	+ 20	+.15
ϑ Bootis	+ 52	−.39
5 Ur. min	+ 76	+.37

May 5.

Azimuth	+ .27
Lev. W. and E.	−.02 + .04
Collim.	+ .13
Prob. error	± .19

Star.	δ	Res.
	°	
η Bootis	+ 19	+.31
50 Cass	+108	−.61
α Dra	+ 65	−.60
α Bootis	+ 20	+.32
ϑ Bootis	+ 52	−.71
5 Ur. min	+ 76	+.83

May 7.

Azimuth	W. −.25 / E. −.47
Lev. W. and E.	−.10 −.07
Collim.	+.15
Prob. error	±.01

Star.	δ	Res.
	°	
α Virg	− 11	−.04
ζ Virg	0	+.03
η Ur. maj	+ 50	.00
η Bootis	+ 19	+.03
50 Cass	+108	Rej.
α Dra	+ 65	−.01
α Bootis	+ 20	−.03

May 8.

Azimuth	−.42
Lev. W. and E.	−.07 −.01
Collim.	+.15
Prob. error	±.10

Star.	δ	Res.
	°	s.
l Leon	+ 11	+.24
δ Leon	+ 21	+.22
δ Crat	− 14	−.46
τ Leon	+ 4	−.01
χ Dra	+ 70	.00
ν Leon	0	+.01
γ Ceph	+103	Rej.

May 9.

Azimuth	W. −1.28 / E. − .67
Lev. W. and E.	+.01 + .06
Collim.	+ .35
Prob. error	± .13

Star.	δ	Res.
	°	s.
η Bootis	+ 19	−.21
50 Cass	+108	Rej.
α Dra	+ 65	.00
α Bootis	+ 20	+.20
ϑ Bootis	+ 52	−.14
5 Ur. min	+ 76	−.30
α² Lib	+ 28	+.59
ε Bootis	− 16	−.35

May 10.

Azimuth	W. −.87 / E. +.60
Lev. W. and E.	−.11 −.03
Collim.	+.45
Prob. error	±.11

Star.	δ	Res.
	°	s.
λ Dra	+ 70	−.03
ν Leon	0	−.18
γ Cep	+103	Rej.
β Leon	+ 15	+.24
γ Ur. maj	+ 54	−.59
ο Virg	+ 9	+.17
4 H. Dra	+ 78	+.79
η Virg	0	+.05

May 11.

Azimuth	W. +.03 / E. +.63
Lev. W. and E.	−.17 −.08
Collim.	+.96
Prob. error	±.02

Star.	δ	Res.
	°	s.
μ¹ Bootis	+ 38	.00
α Coron	+ 27	−.01
α Serp	+ 7	+.01
ε Serp	+ 5	−.01
ξ Ur. min	+ 78	−.08
ε Coron	+ 27	+.10
δ Scorp	− 22	−.06

YORK TIME OBSERVATIONS, 1880—Continued.

MAY 12.

Azimuth +1.33
Lev. W. and E. −.15 −.07
Collim. −11.07
Prob. error ±.02

Star.	δ	Res.
	°	s.
ε Bootis	+28	−.07
α^2 Lib	−16	+.05
β Urs. min.	+75	+.10
β Libr	−9	−.03
α Coron	+27	−.05
α Scorp	+7	+.07

MAY 13.

Azimuth { W. −.18 / E. −.61
Lev. W. and E. −.34 −.20
Collim. −11.15
Prob. error ±.03

Star.	δ	Res.
	°	s.
μ^1 Bootis	+38	+.12
α Coron	+27	−.11
ξ Ur. min	+78	−.04
ε Corn	+27	−.07
β^1 Scor	−19	−.02
Gr. 2,320	+68	+.03
δ Ophiu	−3	+.06

MAY 14.

Azimuth { W. +.12 / E. −.02
Lev. W. and E. −.32 −.30
Collim. −11.15
Prob. error ±.05

Star.	δ	Res.
	°	s.
5 Ur. min	+76	+.10
ε Bootis	+28	−.17
α^2 Libr	−16	+.14
β Ur. min	+75	−.05
48 H. Cap	+103	−.01
β Libr	−9	−.06
μ^1 Bootis	+38	+.08
γ^2 Ur. min	+72	

MAY 15.

Azimuth +.25
Lev. W. and E. −.30 −.27
Collim. +4.15
Prob. error ±.05

Star.	δ	Res.
	°	s.
ξ Virg	0	+.06
η Ur. maj	+50	+.22
η Bootis	+19	−.23
50 Cass	+108	+.03
α Dra	+65	−.10
α Bootis	+20	+.09
ϑ Bootis	+52	−.06

MAY 16.

Azimuth +.06
Lev. W. and E. −.31 −.24
Collim. −4.19
Prob. error ±.02

Star.	δ	Res.
	°	
β Bootis	+41	+.03
β Libr	−9	−.24
μ^1 Bootis	+38	−.07
γ^2 Ur. min	+72	−.02
α Coron	+27	+.06

MAY 18.

Azimuth { W. +.08 / E. +.38
Lev. W. and E. −.35 −.27
Collim. −4.22
Prob. error ±.02

Star.	δ	Res.
	°	
5 Ur. min	+76	+.08
α^2 Libr	−16	+.04
β Ur. min	+75	.01
β Bootis	+41	−.17
β Libr	−9	−.02
μ^1 Bootis	+38	+.08
γ^2 Ur. min	+72	−.05
α Coron	+27	.00

MAY 19.

Azimuth +.17
Lev. W. and E. −.40 −.34
Collim. −4.13
Prob. error ±.05

Star.	δ	Res.
	°	
β Leon	+15	−.03
γ Ur. maj	+54	+.10
ο Virgi	+9	−.05
4 H. Dra	+78	−.19
η Virgi	0	+.23
β Corv	−23	−.16

MAY 20.

Azimuth { W. +.15 / E. +.47
Lev. W. and E. −.22 −.18
Collim. −4.28
Prob. error ±.02

Star.	δ	Res.
	°	
α Coron	+27	−.06
α Scorp	+7	−.02
ε Scorp	+5	+.07
ξ Ur. min	+78	.00
ε Coron	+27	−.05
δ Scorp	−22	+.06
β^1 Scorp	−20	−.03
Gr. 2320	+68	+.03

MAY 21.

Azimuth +.13
Lev. W. and E. −.32 −.25
Collim. −4.25
Prob. error +.05

Star.	δ	Res.
	°	
α^2 Libr	−16	−.10
β Ur. min	+75	−.02
β Bootis	+41	+.11
β Libr	−9	+.13
α Coron	+27	−.12

MAY 22.

Azimuth +.20
Lev. W. and E. −.33 −.32
Collim −4.07
Prob. error ±.02

Star.	δ	Res.
	°	
α Bootis	+20	Rej.
ϑ Bootis	+52	−.01
5 Urs. min	+76	+.02
ε Bootis	+28	−.05
α^2 Libr	−16	+.04
β Ur. min	+75	+.03

MAY 24.

Azimuth +.14
Lev. W. and E. −.49 −.36
Collim. −4.13
Prob. error ±.05

Star.	δ	Res.
	°	
α Bootis	+20	−.01
ϑ Bootis	+52	+.26
5 Urs. min	+76	−.37
ε Bootis	+28	−.01
α^2 Libr	−16	−.08
β Urs. min	+75	+.07

MAY 25.

Azimuth +.04
Lev. W. and E. −.44 −.30
Collim. −5.32
Prob. error ±.08

Star.	δ	Res.
	°	
κ Ophi	+10	−.26
α^1 Herc	+15	+.27
44 Oph		
Gr. 966		
β Drac	+52	+.17
α Ophi	+13	+.09
ω Dra	+69	−.11
μ Herc	+28	−.15

YORK TIME OBSERVATIONS, 1880—Continued.

MAY 26.			MAY 27.			MAY 31.			JUNE 2.		
Azimuth	W. + .15 / E. + .45		Azimuth	W. + .59 / E. + .16		Azimuth	W. — .09 / E. + .23		Azimuth	+ .03	
Lev. W. and E.	—.43	— .38	Lev. W. and E.	—.37	— .37	Lev. W. and E.	—.55	— .48	Lev. W. and E.	—.46	— .38
Collim.	—4.88		Collim.	—5.13		Collim.	—5.46		Collim.	—5 65	
Prob. error	± .04		Prob. error	± .02		Prob. error	± .08		Prob. errer	± .02	
Star.	δ	Res.	Star.	δ	Res.	Star.	δ	Res.	Star.	δ	Res.
	°	s.		°	s.		°	s.		°	s.
ζ Virgi	0	+.05	α Virg	—11	—.04	β Libr	— 9	—.02	ε Scorp	+ 5	—.01
η Ur. maj ...	+ 50	+.16	η Ur. maj ...	+ 50	—.03	γ² Ur. min ..	+72	+.01	ζ Ur. min ...	+78	—.14
η Bootis	+ 19	—.03	η Bootis ...	+19	+.04	α Coron.....	+27	+.06	ε Coron	+27	+.12
50 Cass	+108	+.07	α Drac	+65	+.02	α Scorp	+ 7	—.20	δ Scorp	—22	—.04
α Drac	+ 65	—.08	α Bootis .	+20	+.01	ε Scorp ...	+ 5	—.19	Gr. 2320.....	+68	—.01
α Bootis	+ 20	—.03	ϑ Bootis	+52	—.06	ζ Ur. min ...	+78	+.22	δ Ophi	— 3	—.03
ϑ Bootis	+ 52	+.09				δ Scorp . .	—22	+.36	τ Herc	+47	+.06

JUNE 6.			JUNE 7, I.			JUNE 7, II.			JUNE 8.		
Azimuth	W. + .19 / E. — .17		Azimuth	+ .10		Azimuth	W. — .32 / E. + .03		Azimuth	W. — .01 / E. + .08	
Lev. W. and E.	—.60	— .55	Lev. W. and E.	—.45	— .45	Lev. W. and E.	—.45	— .40	Lev. W. and E.	—.44	— .54
Collim.	—5.64		Collim.	—5.60		Collim.	—5.54		Collim.	—5.68	
Prob. error	± .04		Prob. error	± .04		Prob. error	± .04		Prob. error	± .04	
Star.	δ	Res.	Star.	δ	Res.	Star.	δ	Res.	Star.	δ	Res.
	°	s.		°	s.		°	s.		°	s.
α Bootis ...	+ 20	—.07	δ Scorp	—22	—.08	A Dra	+69	+.18	γ² Ur. min ..	+72	—.04
ϑ Bootis	+ 52	+.11	β¹ Scorp	—20	—.05	ζ Ophi	—10	+.09	α Coron.....	+27	—.07
5 Ur. min ...	+ 76	—.09	Gr. 2320	+68	—.01	η Herc.....	+39	—.18	α Scorp	+ 7	+.06
β Ur. min ...	+ 75	Rej.	δ Ophi	— 3	+.17	κ Ophi	+10	—.07	ε Scorp	+ 5	—.05
48 H. Cep ...	+103	Rej.	τ Herc.....	+47	Rej.	d Her.....	+34	+.11	ζ Ur. min ...	+78	—.12
β Libræ	— 9	+.04	α Scorp ...	—26	.00	ε Ur. min ...	+82	—.10	ε Coron.....	+27	+.20
μ¹ Bootis	+ 38	—.08				α¹ Herc	+15	—.01	δ Scorp	—22	+.10
γ² Ur. maj...	+ 72	+.06							β¹ Scorp ..	—19	—.21

Corrections to chronometer 2490 from star observations.

Date.	Epoch.	Δ T.	Rate per second.	r. ±	Date.	Epoch.	Δ T.	Rate per second.	r. ±
1880.	h.	m. s.	s.	s.	1880.	h.	m. s.	s.	s.
Mar. 17	7.4	— 8 13.25	.....	.06	May 4	14.8	42 56.32	—.0005006	.09
17	11.0	8 19.24	—.000462	.11	5	14.8	43 39.92	5046	.19
20	13.1	10 31.73	4967	.18	7	14.5	45 5.43	4980	.01
21	9.2	11 7.94	5004	.15	8	12.0	45 47.74	4950	.10
22	7.4	11 47.85	4992	.05	9	15.0	46 31.58	4922	.13
23	9.4	13 33.84	4914	.21	10	12.6	47 9.79	4914	.11
24	9.4	13 16.32	4917	.11	11	16.5	47 59.62	4961	.02
25	7.9	13 56.36	4943	.07	12	15.9	48 41.09	4923	.02
30	7.8	17 31.36	4980	.11	13	16.6	49 25.62	5008	.03
31	8.2	18 14.31	4890	.08	14	15.7	50 7.36	5019	.05
April 1	13.2	19 5.98	4949	.06	15	14.8	50 48.97	5004	.05
3	12.3	20 30.40	4979	.04	16	16.1	51 34.80	5032	.02
4	11.6	21 11.64	4917	.08	18	16.9	53 16.09	5015	.02
5	12.4	21 53.80	4722	.23	19	12.9	53 38.83	4992	.05
6	12.6	22 41.01	5419	.25	20	16.7	54 28.67	4980	.02
7	12.5	23 24.28	5054	.05	21	16.0	55 10.40	4975	.05
8	12.2	24 7.67	5086	.04	22	15.5	55 52.49	4975	.05
17	12.4	30 30.03	4913	.04	24	15.5	57 18.57	4971	.06
18	14.2	31 16.65	5019	.04	25	18.3	58 6.04	4922	.08
20	10.1	32 36.65	5062	.04	26	14.9	58 42.87	4966	.04
21	14.1	33 27.31	5026	.11	27	14.9	59 24.67	4838	.02
22	9.8	34 03.03	5037	.13	31	16.6	62 17.85	4924	.08
26	15.0	37 7.65	5068	.08	June 2	17.1	63 44.14	4984	.02
27	14.9	37 51.22	5064	.08	6	15.9	66 33.69	4968	.04
28	11.0	38 27.60	5028	.07	7	17.3	67 19.24	4921	.03
May 3	11.5	42 6.90	5055	.10	7	17.9	67 19.85	282	*.04
				Prob. error.	8	16.9	68 0.40	4935	.04
3	12.4	42 8.74	568	±.10					

*Rejected.

Chronometer comparisons, York, Pa.

Date.	Epoch by 202.	Seconds by 202 of exact minute by chronometer.		
		380.	2490.	1589.
1880.	*h.*	*s.*	*s.*	*s.*
	23.03	4.36	12.82	11.81
Mar. 15	4.57	13.08	21.88	21.10
	21.52	39.30	49.00	49.10
16	4.97	51.08	1.06	1.39
	20.88	16.07	26.67	27.88
17	5.45	29.69	40.67	42.15
	7.97	33.55	44.65	46.21
	11.75	39.41	50.67	52.44
	20.48	53.07	4.67	6.92
18	5.30	7.19	19.19	21.76
	20.65	51.25	43.95	47.34
19	5.35	45.15	58.27	1.91
	11.75	55.26	8.73	12.65
	20.77	9.31	23.36	27.71
20	5.33	23.11	37.49	42.12
	14.03	36.75	51.51	56.65
	20.90	47.62	2.77	8.21
21	5.—	3.05	16.75	22.43
	9.82	10.94	24.03	29.97
	21.37	31.57	42.88	49.39
22	5.33	44.87	56.02	2.79
	7.93	49.17	0.28	7.07
	21.13	11.14	21.67	29.19
23	5.62	24.74	35.69	43.39
	9.80	31.20	42.40	50.39
	21.05	48.70	0.37	9.19
24	5.50	2.05	14.05	23.37
	9.90	8.94	21.16	30.72
	21.4	27.00	39.69	50.16
25	5.77	40.35	53.53	4.40
	8.08	43.96	57.25	8.20
	21.60	5.47	19.41	31.02
26	5.78	18.56	32.95	44.81
	11.48	27.42	42.16	54.29
	21.52	43.23	58.44	11.11
27	6.03	56.91	12.58	25.50
	11.13	3.86	20.89	33.96
	21.93	21.77	38.40	51.99
28	5.92	34.60	51.71	5.48
	11.02	42.59	0.08	13.96
	21.62	59.09	17.29	31.69
29	6.07	12.39	31.14	45.90
	12.33	22.07	41.21	56.36
	22.15	37.30	56.83	12.61
30	6.22	50.44	9.96	26.06
	8.23	53.51	13.20	29.33
	21.78	14.72	35.12	51.97
31	6.37	28.25	49.19	6.36
	8.92	32.11	53.23	10.50
	21.87	52.11	13.94	31.97
April 1	6.13	5.10	27.42	45.74
	13.8—	17.00	39.89	58.57
	21.75	29.41	52.80	11.90
2	6.45	43.20	7.01	26.40
	12.25	52.14	16.35	36.04
	21.82	7.04	31.86	51.98
3	6.18	20.29	45.67	6.14
	12.71	30.39	56.22	16.98
	21.97	44.76	11.17	32.45

Date.	Epoch by 202.	Seconds by 202 of exact minute by chronometer.		
		380.	2490.	1589.
1880.	*h.*	*s.*	*s.*	*s.*
April 4	6.87	58.88	25.76	47.40
	11.03	5.35	32.50	54.38
	22.08	22.73	50.45	12.99
5	6.63	36.48	4.56	27.48
	11.80	44.04	12.93	36.20
	22.23	1.19	29.90	53.87
6	6.62	14.71	43.90	8.20
	13.50	25.69	55.22	19.76
	22.05	39.40	9.36	34.45
7	6.90	53.90	24.31	49.70
	11.97	2.03	32.67	58.28
	22.68	19.39	50.47	16.65
8	6.82	32.77	4.22	30.61
	12.65	42.05	13.86	40.49
	23.85	27.29	58.79	35.67
16	7.93	39.92	11.89	49.19
	23.03	3.27	36.23	14.60
17	7.82	17.11	50.69	29.46
	11.75	23.25	57.08	36.06
	23.27	41.36	15.73	55.47
18	8.23	55.83	30.62	10.69
	13.03	03.42	38.45	18.73
	23.62	20.73	55.73	36.69
19	8.01	34.20	9.63	50.89
	23.42	59.39	34.81	16.96
20	8.10	13.22	49.27	31.73
	10.67	17.21	53.47	36.06
	23.83	37.75	14.78	58.19
21	7.95	50.51	28.19	11.97
	12.93	58.23	36.29	20.33
	23.15	14.29	52.96	37.62
22	8.18	20.20	7.90	52.93
	10.17	32.34	11.08	56.16
	23.65	54.12	33.10	18.98
23	7.7—	6.99	46.42	32.70
	23.42	31.76	12.20	59.48
24	8.23	46.42	26.94	14.45
	15.05	57.59	38.08	25.96
	23.80	11.94	52.47	40.88
25	8.93	27.17	7.69	56.50
	13.22	34.16	14.68	3.78
	23.73	51.49	31.92	21.70
26	8.57	6.27	46.65	36.79
	15.60	17.79	58.08	48.68
	23.57	30.89	11.12	2.25
27	8.57	45.36	26.09	17.58
	15.43	56.40	37.31	29.20
	0.08	10.23	51.47	43.90
28	8.45	23.71	5.40	58.15
	11.48	28.49	10.35	3.20
	0.25	48.56	31.10	24.81
29	8.42	1.68	44.56	38.73
	23.97	26.26	9.90	(?)5.08
30	8.73	40.25	24.43	20.00
	16.97	53.28	37.88	34.08
	0.23	4.88	49.85	46.50
May 1	8.47	18.64	3.54	0.60
	0.43	44.89	29.67	27.75
2	9.33	59.18	44.57	43.05

Chronometer comparisons, York, Pa.—Continued.

Date.	Epoch by 202.	Seconds by 202 of exact minute by chronometer.		
		380.	2490.	1589.
1880.	*h.*	*s.*	*s.*	*s.*
May 2	14.40	7.25	52.90	51.70
	0.18	22.78	8.86	8.37
3	8.61	36.17	22.78	22.70
	12.93	42.98	29.82	29.08
	0.68	1.41	48.81	49.79
4	8.65	14.04	1.98	3.24
	14.13	22.54	10.89	12.41
	0.42	38.66	27.65	29.78
5	8.87	52.25	41.52	44.09
	15.32	2.30	51.93	54.90
	0.35	16.55	6.59	10.19
6	9.18	30.56	21.11	25.20
	0.70	54.62	46.18	51.22
7	9.22	8.70	0.09	5.54
	13.78	15.96	7.27	12.99
	0.50	33.10	24.29	30.84
8	9.01	46.49	38.38	45.32
	12.47	51.60	43.77	50.91
	1.07	10.97	3.89	11.94
9	9.48	24.05	17.49	25.99
	14.42	31.50	25.26	34.03
	0.60	46.96	41.25	50.76
10	9.58	0.78	55.76	5.70
	13.13	6.11	1.30	11.44
	0.88	24.05	19.07	30.70
11	9.35	37.11	33.36	44.78
	16.87	48.67	45.40	57.24
	0.88	1.09	58.31	10.71
12	9.88	15.31	12.98	25.77
	15.22	23.66	21.50	34.71
	0.80	38.70	36.99	50.90
13	9.38	52.38	51.09	5.45
	17.01	4.59	3.59	18.44
	1.23	17.36	16.62	32.00
14	9.33	30.48	30.22	45.90
	15.08	39.49	39.59	55.56
	1.13	55.40	56.06	12.05
15	9.75	9.90	10.39	27.21
	15.32	18.99	19.43	36.55
	0.97	34.76	35.07	52.77
16	10.33	50.44	50.60	8.71
	15.45	58.87	58.96	17.32
	1.08	14.85	14.69	33.65
17	10.36	30.34	29.98	49.29
	19.21	44.93	44.30	4.09
	1.23	54.85	54.09	14.23
18	9.70	9.09	7.99	28.53
	15.07	17.96	16.73	37.51
	1.37	34.89	33.33	54.72
19	10.17	49.63	47.81	9.57
	13.48	55.07	53.14	15.09
	1.52	14.91	12.50	35.21
20	10.30	29.60	26.95	49.99

Date.	Epoch by 202.	Seconds by 202 of exact minute by chronometer.		
		380.	2490.	1589.
1880.	*h.*	*s.*	*s.*	*s.*
May 20	16.17	39.27	36.41	59.73
	1.42	54.60	51.39	15.25
21	10.33	9.69	5.99	30.19
	15.45	18.20	14.24	38.74
	1.35	34.81	30.23	55.30
22	10.68	50.84	45.56	11.01
22	15.90	59.69	53.95	19.77
	2.18	17.19	10.59	37.06
23	10.2—	31.03	23.79	50.62
	15.57	40.13	32.43	59.52
	1.87	57.72	49.10	16.85
24	10.48	12.60	3.34	31.39
	15.92	21.80	12.11	40.45
	2.00	38.91	28.39	57.35
25	17.50	5.31	53.63	23.30
	1.75	19.11	6.79	36.92
26	10.55	34.04	21.07	51.59
	15.52	42.17	28.97	59.70
	2.40	0.24	46.26	17.78
27	10.62	14.08	59.58	31.46
	15.48	22.06	7.30	39.43
	2.02	39.15	23.98	56.80
28	11.02	53.96	38.59	11.69
	2.20	18.64	2.90	36.89
29	10.90	33.37	17.17	51.41
	16.62	42.88	26.41	0.90
	3.1—	0.44	43.49	18.49
30	11.05	13.97	56.58	31.83
	16.85	23.71	6.02	41.50
	2.30	39.48	21.28	57.28
31	11.15	54.55	35.87	12.18
	17.12	4.65	45.50	22.10
	2.18	19.95	0.07	37.35
June 1	10.90	34.76	14.26	51.90
	2.70	1.22	39.66	18.39
2	11.45	16.11	54.02	33.09
	17.43	26.19	3.74	43.10
	2.2	41.02	18.07	57.95
3	10.93	56.00	32.49	12.73
4	11.1	37.02	12.07	53.56
	18.38	49.33	23.90	5.69
	2.80	3.47	37.51	19.86
5	11.12	17.78	51.45	34.06
	18.25	29.52	2.91	45.80
	3.63	45.22	18.16	1.50
6	11.90	59.20	31.77	15.39
	16.63	7.02	39.39	23.23
	2.82	23.69	55.71	40.29
7	11.62	38.19	10.04	54.94
	18.42	49.17	20.78	6.07
	2.97	3.11	34.49	20.31
8	11.53	17.37	48.36	34.52
	16.20	24.86	55.68	42.11

REPSOLD STAND.

Arc.	March 19, name forward. Heavy end down. L.	R.	Heavy end up. L.	R.	March 21, name back. Heavy end up. L.	R.	Heavy end down. L.	R.	March 22, name forward. Heavy end down. L.	R.	Heavy end up. L.	R.
550	9h m. s.	9h m. s.	10h m. s.	10h m. s.	21h m. s.	21h m. s.	22h m. s.	22h m. s.	10h m. s.	10h m. s.	12h m. s.	12h m. s.
40												
30												
20			40 38									
10												
500	35 59		41 19				44 49					
490	35 59		41 37				45 34					
80	36 44		42 00				46 18					
70			42 21								17 91	
60	38 21		42 43		31 10				15 40		18 14	
50			43 5		31 30		48 49		16 36		18 39	
40			43 30		31 51		49 51				19 3	
30												
20	42 24				32 40		51 36		19 34		19 58	
10											20 21	
400			45 18				53 37				20 55	
390											21 23	
80											21 54	
70												
60	49 25		47 24		35 35		58 11					
50					36 7							
40												
30	53 50		49 18						31 7			
20					37 58		63 28					
10							64 59		34 12	33 59		
300	58 56		51 31				66 34	65 44	35 58	35 48		
290	60 30								37 43	37 34	28 4	
80							70 3					28 15
70	64 43		54 7	53 35			71 52	70 47			29 56	
60			55 5	54 28	42 44		73 58	72 51			30 55	30 03
50			56 13		43 40				45 59	45 43		
40				56 33			78 27	77 20	48 21	48 8	32 55	
30	74 7		58 30		45 39	45 29	80 51					
20	76 43		59 47	58 58		46 52	83 24	82 0	53 27	53 8	35 29	
10	79 39		61 4						56 22	56 10		35 36
200	22 49		62 25	61 33			89 1	87 44				
190	86 0				50 44	50 40	92 21	90 37				
80					52 19						41 22	39 55
70	93 34	94 16		66 13			90 14	97 30	69 58	69 45		41 41
60	97 50	98 16	69 11	67 57					74 1	73 38	44 59	43 23
50	102 20	102 51	71 12		57 21	57 8	107 19	105 29			46 56	
40	107 20	108 4	73 24		59 30	59 23			83 7		49 23	
30	113 2	113 43	75 43				117 30	114 36	88 11	87 46	51 33	49 49
20	119 23	120 17			64 20	64 14	123 8		94 2	93 22	54 30	52 28
10	126 22	127 12	81 28	79 47	67 00	66 38	129 26	125 50	100 33		57 52	55 8
100	133 28	134 38	84 46	82 46			136 34	132 26	114 93		60 56	58 13
90	142 4	143 11	88 39	86 33	73 43				114 93	114 5		61 41
80			93 36	90 29								
70												
60												

Knife 3–4 at light end.
Knife 7–8 at heavy end.

Knife 3–4 at heavy end.
Knife 7–8 at light end.

REPSOLD STAND—Continued.

Arc.	March 23, name back.				March 26, name forward.				March 27, name back.			
	Heavy end up.		Heavy end down.		Heavy end down.		Heavy end up.		Heavy end up.		Heavy end down.	
	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.
	10h m. s.	10h m. s.	11h m. s.	11h m. s.	8h m. s.	8h m. s.	10h m. s.	10h m. s.	m. s.	m. s.	9h m. s.	9h m. s.
550												
40												
30												
20												
10											12 32	
500			35 11								13 22	
490			35 54		22 50							
80			36 41						4 32			
70			37 34				31 4		4 57			
60	27 52				25 17		31 25		5 17			
50	28 13				26 12		31 51		5 42			
40	28 37		40 15		27 4		32 12		6 7			
30												
20			42 19				33 3					
10					29 55				7 22			
400	30 25						33 58		7 52			
390							34 27		8 20			
80	31 24				33 3							
70												
60			49 22		35 28				9 57			
50									10 31			
40	33 35		52 7									
30	34 18		53 49									
20												
10			56 45	56 9			39 1	38 47				
300					44 13		39 48	39 40				
290					45 35	45 2						
80	37 58	38 10			47 33		41 18			15 51		
70			64 35	63 35								
60					51 42					17 40		
50	40 41	40 54										
40					56 4				19 12	19 40		
30			74 13		58 29				20 18	20 48		
20			76 54	65 25								
10	45 25	45 35	79 54	68 29	63 45	62 28			22 45	23 15		
200				71 20	66 50	65 29						
190	48 4	48 14			70 3	68 44			25 31			
80		50 2	89 48	78 56	73 24	71 44	52 43		26 58	27 42		
70						75 32	54 19	53 31		29 26		
60			97 39	95 38	81 6		56 11	55 21		31 15		
50	54 59	55 34	102 7	99 58	85 20	83 31						
40	57 15	57 38	107 9	104 27	89 54	88 42	60 6	59 2	34 25	35 17		
30			112 29	109 40	95 54	93 27	62 11	61 1	36 39	37 36		
20	62 18	62 57	118 39	115 41	100 39		65 0		39 02			
10	65 7		125 26	121 37	107 46	104 36	67 32	65 55	42 12	43 14		
100	68 2	68 56	132 38		114 52	112 29	70 36	68 49		46 14		
90	71 29	72 31			122 43	119 47	74 6	72 14	48 28	49 56		
80		76 47					78 26					
70												
60												

Knife 3–4 at heavy end.
Knife 7–8 at light end.

UNITED STATES COAST SURVEY PENDULUM AT YORK, PA., 1880.

LENGTH.

Date.	Position heavy end and name.	Knife edge.	Ther. K.	Ther. Z.	K—K —.54	Metal ther.	Above.			Below.			Uncorrected difference.	Corrected for difference of thers.	Corrected difference.	Mean.	General mean.
			On pend.	On stand.			Stand.	Pend.	P—st.	Stand.	Pend.	P—st.					
1880.			°	°	°												
Mar. 3	Down, forward.	7-8 at heavy end..	19.83	19.32	—.03	+166	4900	5093	+193	5040	4958	—82	+275	+06	+281		
		3-4 at light end...	19.98	19.48	—.04	+210	4911	5095	+184	5062	4975	—87	+271	+07	278		
			20.03	19.56	—.06	+218	4891	5086	+195	5054	4976	—78	+273	+11	284		
			20.10	19.62	—.06	+222	4900	5092	+192	5056	4990	—66	+258	+11	269		
			20 10	19.62	—.06	+228	4895	5085	+190	5066	4973	—93	+283	+11	294		
			20.06	19.61	—.09	+224	4902	5077	+175	5063	4984	—79	+254	+17	271		
												Mean.	+269				+279

Date.	Position heavy end and name.	Knife edge.	Ther. K.	Ther. Z.	K—Z —.54	Metal ther.	Above.			Below.			Uncorrected difference.	Corrected for difference of thers.	Corrected difference.		
			On stand.	On pend.			Stand.	Pend.	P—st.	Stand.	Pend.	P—st.					
1880.			°	°	°												
May 7	Up, forward....	7-8 at heavy end..	24.10	23.76	—.20	+870	4910	5031	+121	5063	4923	—140	+261	—37	+224		
		3-4 at light end...	24.10	23.76	—.20	+877	4893	5012	+119	5054	4916	—138	+257	—37	220		
	7	.....	24.10	23.94	—.38	+868	4935	5026	+ 91	5067	4986	—171	+262	—70	+192	+222	
			24.12	23.90	—.32	+880	4938	4994	+ 56	5062	4904	—158	+214	—59	155		
			24.12	23.83	—.25	+883	4942	4994	+ 52	5064	4908	—156	+208	—46	162		
			24.11	23.79	—.22	+885	4936	4996	+ 60	5060	4908	—152	+212	—40	172		
	8	.....	24.22	23.97	—.29	+875	4907	5010	+103	5064	4911	—153	+256	—53	+203	+170	
			24.33	24.04	—.25	+882	4907	5007	+100	5057	4908	—149	+249	—46	193		
												Mean.	+243			+198	+197
June 9	Down, back....	3-4 at heavy end.	25.04	24.45	+.05	+ 46	5230	5539	+309	4969	4999	+ 30	+279	+09	+288		
		7-8 at light end...	25.15	24.55	+.06	+ 72	5226	5538	+312	4972	5008	+ 36	+276	+11	287		
			25.26	24.62	+.10	+ 95	5228	5549	+321	4971	5011	+ 40	+281	+18	299		
			25.49	24.74	+.21	+154	5267	5549	+282	4981	5000	+ 19	+263	+39	+302	+192	
			25.40	24.63	+.23	+139	5260	5537	+277	4975	5003	+ 28	+249	+42	291		
			25.34	24.60	+.20	+122	5262	5544	+282	4977	5007	+ 30	+252	+37	289		
			26.50	25.82	+.14	+294	4947	5119	+172	5109	4956	—153	+325	+26	+351	+294	
			26.62	25.96	+.12	+305	4931	5080	+149	5115	4947	—168	+317	+22	339		
			26.69	26.06	+.09	+320	4931	5090	+159	5105	4965	—140	+299	+17	316		
			27.60	26.91	+.15	+476	4967	5114	+147	5122	4963	—159	+306	+28	+334	+335	
			27.65	26.96	+.15	+489	4957	5102	+145	5123	4961	—162	+307	+28	335		
			27.70	27.00	+.16	+497	4961	5094	+133	5116	4963	—153	+286	+29	315		
												Mean.	+286			+328	+316

CENTER OF MASS.

Date.	Knife at heavy end and fig. for.	Position of name.	Heavy end.		Light end.				$h_d - h_a$	Concluded $h_d - h_a$
			Read in middle.	Read at end.	Read in middle.	Read at end.				
1880.										
March 22	7–8	U	17041	.00089	56047	00641	16052	55406	39354	
	7	D	041	986	047	640	055	407	353	39353
22	3–4	U	041	978	056	652	063	404	341	
	3	D	041	976	056	646	065	410	345	343
28	3–4	U	17007	.00948	56056	00654	16050	55402	343	
	4	D	007	946	056	658	061	398	337	340
	7–8	U	007	955	047	642	052	405	353	
	8	D	007	946	047	641	061	406	345	349
April 26	3–4	U	17012	.00956	56056	00644	16056	55412	356	
	4	D	012	953	056	648	059	408	349	353
	7–8	U	012	960	057	650	052	407	355	
	8	D	012	956	057	654	056	403	347	351
May 10	Fig. roll.	U	16999	.00984	56057	00650	16015	55407	392	
	1–2	D	999	976	057	650	023	407	384	388
	Point roll.	U	999	987	047	643	012	404	392	
	1–2	D	999	972	047	638	027	409	382	387
May 30	3–4	U	17018	.00962	56046	00644	16056	55402	346	
	4	D	018	958	046	643	060	403	343	344
	7–8	U	018	964	063	657	054	406	352	
	7	D	018	966	063	658	052	405	353	353

Mean for knife edges .. 39348
Correction..... +14
Adopted value 39362

PERIODS OF OSCILLATION.

Observations by transits.

SOLID SUPPORT, 7–8 AT HEAVY END.

Date.	Position of heavy end.	Time of transit.	Interval.	Corrected for arc.	Corrected interval.	Number oscillations.	Time, one oscillation.	Rate.	Press.	Temp.	Period corrected.
		h. m. s.									
Mar. 31	.....	10 15 36.073									
	D	11 46 47.838	5471.765	.109	5471.656	5434	1.006930	−493	+ 1	− 7	1.006431
		12 10 29.879									
	U	12 58 00.653	2850.774	.066	2850.708	2831	962	−493	+ 3	−11	1.006461
Apr. 2	.....	8 53 38.118									
	U	9 38 18.774	2680.656	.066	2680.590	2662	1.006984	−495	+ 3	−26	1.006466
		10 22 41.921									
	D*	12 03 39.912	6057.991	.142	6057.849	6016	6957	−405	+ 2	−29	1.006435

KNIVES INTERCHANGED, 3–4 AT HEAVY END.

Apr. 4	.....	22 38 09.925									
	D	00 19 17.017	6067.092	.155	6066.937	6025	1.006961	−505	+ 6	−24†	1.006438
		00 48 10.087									
	U	1 35 59.138	2869.051	.067	2868.984	2849	7014	−505	+15	−29	1.006495
4	.....	7 47 03.789									
(Eve.)	U	8 35 35.084	2911.295	.066	2911.229	2891	1.006997	−498	+15	−27	1.006487
		9 06 07.847									
	D	10 51 53.915	6346.068	.155	6345.913	6302	6968	−498	+ 7	−32	1.006445

* Fulcrum plane leveled up between these two.
† Temperatures uncertain.

PERIODS OF OSCILLATION—Continued.

REPSOLD SUPPORT.

Date.	Position of heavy end.	Time of transit, 7–8 at heavy end.	Interval.	Corrected for arc.	Corrected interval.	Number oscillations.	Time. one oscillation.	Rate.	Press.	Temp.	Period corrected.
		h. m. s.									
Apr. 7	.....	8 50 26.405									
	D	10 29 29.957	5943.552	.145	5943.407	5902	1.007016	−508	− 1	− 4	1.006503
		10 52 16.426									
	U	11 41 03.947	2927.521	.067	2927.454	2907	1.007036	−508	− 4	− 6	1.006518
30	.....	13 17 46.043									
	U	14 02 47.919	2701.876	.069	2701.807	2683	1.007010	−507	+ 1	−15	1.006489
		15 16 49.902									
	D	16 47 27.927	5438.025	.149	5437.876	5400	1.007014	−507	0	−12	1.006495

KNIVES INTERCHANGED.

May 2	.....	10 53 29.957									
	D	12 33 21.935	5991.978	.149	5991.829	5950	1.007030	−509	+ 3	−28*	1.006496
		13 13 53.872									
	U	14 09 09 124	3315.252	.067	3315.185	3292	1.007043	−509	+ 8	−35	1.006507
3	.....	13 33 15.959									
	U	14 23 37.156	3021.197	.069	3021.128	3000	1.007042	−501	+ 8	−45	1.006504
		15 42 16.912									
	D	17 26 53.969	6277.047	.155	6276.892	6233	.....	−501	+ 4	−49	1.006496

GENEVA SUPPORT.

May 19	.....	13 48 16.053									
	U	14 25 41.781	2245.728	.024	2245.704	2230	1.007042	−499	+15	−58	1.006500
		14 57 22.105									
	D	16 25 07.759	5265.654	.077	5265.577	5229	1.006995†	−499	+ 7	−61	1.006442

KNIVES INTERCHANGED.

May 22	.....	16 09 27.795									
	U	16 45 19.974	2152.179	.026	2152.153	2137	1.007090	−500	+14	−66	1.006538
		17 23 14.141									
	D	18 51 17.984	5283.843	.072	5283.771	5247	1.007008	−500	+ 6	−65†	1.006449

* Temperature uncertain. † Door at head of styss opened.

Observations by coincidences.

HEAVY END DOWN.

REPSOLD SUPPORT, KNIFE 3–4.

Date.	Direction of motion.	Coincidence.	Interval.	Arc.	Corr. for arc.	No. of coin.	Inter. succes. coinc.	Recip., 1 less.	Period.	Corrections.			Corrected period.
										Rate.	Press.	Temp.	
1880.		h. m. s.	s.				s.		s.				s.
Mar. 19	R. L.	8 45 43	.....	.0390									
		9 28 44	2581	.0184	47	9	143.4	7022	1.006975	−491	+ 2	+ 5	1.006491
		10 16 32	2868	.0096	12	10	143.4	7022	1.007010	491	2	4	1.006525
	L. R.	8 52 49	.....	.0337									
		9 30 57	2288	.0178	40	8	143.0	7042	1.007002	−491	+ 2	+ 5	1.006518
		10 18 53	2876	.0095	11	10	143.8	7003	1.006992	491	2	4	1.006507
21	R. L.	22 54 53	.....	.0393									
		23 37 54	2581	.0177	46	9	143.4	7022	1.006976	−505	− 5	+22	1.006488
		24 21 10	2596	.0099	12	9	144.2	6983	1.006971	505	5	21	1.006482
	L. R.	22 52 31	.....	.0416									
		23 37 57	2726	.0177	46	9½	143.5	7018	1.006952	−505	− 5	+22	1.006484
		24 23 35	2738	.0096	12	9½	144.1	6988	1.006976	505	5	21	1.006487

HEAVY END DOWN—Continued.

KNIVES INTERCHANGED, KNIFE 7–8.

Date.	Direction of motion.	Coincidence.	Interval.	Arc.	Corr. for arc.	No. of coin.	Inter. succes. coinc.	Recip., 1 less.	Period.	Corrections.			Corrected period.
										Rate.	Press.	Temp.	
1880.		h. m. s.	s.				s.		s.				s.
Mar. 22	R. L.	10 27 21	.....	.0357									
		12 3 2	5741	.0082	23	20	143.5	7018	1.006995	−499	− 1	+13	1.006510
	L. R.	10 29 43	.....	.0343									
		12 00 32	5449	.0086	23	19	143.4	7022	1.006999	−499	− 1	+13	1.006514
23	R. L.	11 43 28	.....	.0404									
		12 28 34	2706	.0181	49	9½	142.4	7072	1.007023	−491	+ 3	− 2	1.006533
		13 14 13	2739	.0096	12	9½	144.2	6983	1.006971	491	3	1	1.006481
	L. R.	11 45 50	.....	.0385									
		12 28 39	2589	.0181	46	9	143.8	7003	1.006957	−491	+ 3	− 2	1.006467
		13 11 48	2589	.0099	12	9	143.8	7003	1.006991	491	3	1	1.006503

SOLID SUPPORT, KNIFE 7–8.

Mar. 26	R. L.	8 38 53	.....	.0331									
		10 05 43	5210	.0085	21	18	144.7	6959	1.006938	−495	− 3	+ 8	1.006448
	L. R.	8 36 32	.....	.0351									
		10 08 11	5499	.0082	23	19	144.7	6959	1.006936	−495	− 3	+ 8	1.006446
27	R. L.	9 25 37	.....	.0272									
		10 57 5	5488	.0092	18	19	144.4	6974	1.006956	−499	+ 8	− 9	1.006456
	L. R.	9 27 58	.....	.0254									
		10 54 42	5204	.0095	17	18	144.6	6964	1.006947	−499	+ 8	− 9	1.006447

SOLID SUPPORT, KNIFE 3–4.

Mar. 28	R. L.	8 10 57	.....	.0352									
		9 44 07	5230	.0086	24	18	145.3	6930	1.006906	−502	+ 3	+13	1.006420
	L. R.	8 14 35	.....	.0374									
		9 46 33	5518	.0083	25	19	145.2	6935	1.006910	−502	+ 3	+13	1.006424
29	R. L.	10 39 32	.....	.0374									
		12 11 27	5515	.0079	27	19	145.1	6940	1.006913	−492	− 1	+ 7	1.006427
	L. R.	10 41 57	.....	.0352									
		12 9 1	5224	.0077	22	18	145.1	6940	1.006918	−492	− 1	+ 7	1.006434

RUBBER SUPPORT, KNIFE 7–8.

Apr. 18	R. L.	10 17 21	.....	.0350									
		11 31 19	4438	.0088	24	16	138.7	7262	1.007238	−506	+ 1	−20	1.006713
	L. R.	10 15 01	.....	.0372									
		11 33 39	4718	.0085	25	17	138.8	7257	1.007232	−506	+ 1	−20	1.006707
20	R. L.	12 14 32	.....	.0382									
		13 37 43	4991	.0084	36	18	138.6	7267	1.007231	−504	+ 2	−32	1.006707
	L. R.	12 16 49	.....	.0362									
		13 30 45	4436	.0093	26	16	138.6	7267	1.007241	−504	+ 2	−32	1.006707

HEAVY END DOWN—Continued.

WOODEN SUPPORT, KNIFE, 7–8.

Date.	Direc. tion of motion.	Coincidence.	Interval.	Arc.	Corr. for arc.	No. of coin.	Inter. succes. coinc.	Recip., 1 less.	Period.	Corrections.			Cor. rected period.
										Rate.	Press.	Temp.	
1880.		h. m. s.	s.				s.		s.				s.
Apr. 24	R. L.	12 34 43	.....	.0374									
		13 50 12	4529	.0114	31	16	141.5	7117	7086	−507	+ 2	−30	6551
	L. R.	12 32 26	.....	.0392									
		13 52 39	4813	.0101	30	17	141.6	7112	7082	−507	+ 2	−30	6547.
25	R. L.	11 34 47	.....	.0361									
		12 59 50	5103	.0099	33	18	141.8	7102	7069	−508	+ 2	−21	6545
	L. R.	11 32 26	.....	.0380									
		13 02 16	5390	.0095	28	19	141.8	7102	7074	−508	+ 2	−21	6547
27	R. L.	15 49 14	.....	.0363									
		17 14 32	5118	.0097	26	18	142.2	7082	7056	−508	0	−18	6530
	L. R.	15 46 54	.....	.0383									
		17 16 54	5400	.0094	28	19	142.1	7087	7059	−508	0	−18	6533
28	R. L.	12 36 16	.....	.0363									
		14 01 33	5117	.0097	26	18	142.1	7087	7061	−505	0	−27	6529
	L. R.	12 33 53	.....	.0381									
		14 3 55	5402	.0095	16	19	142.1	7087	7071	−505	0	−27	6539

GENEVA SUPPORT. BELLS OFF, KNIFE 3–4.

May 18	L. R.	12 10 05	.....	.0268									
		13 31 25	4880	.0081	16	17	143.5	7018	1.007002	−503	+ 6	−50	1.006453
	R. L.	12 12 29	.....	.0255									
		13 29 05	4596	.0083	16	16	143.6	7013	1.006997	503	6	50	1.006446

KNIVES INTERCHANGED, KNIFE 7–8.

May 23	R. L.	12 41 42	.....	.0255									
		14 2 56	4874	.0073	14	17	143.4	7022	1.007008	−498	+ 6	−61	1.006455
	L. R.	12 44 05	.....	.0243									
		14 00 27	4582	.0076	14	16	143.2	7032	1.007018	498	6	61	1.006464

GENEVA SUPPORT. BELLS ON, KNIFE 7–8.

May 26	R. L.	16 9 18	.....	.0244									
		18 8 30	7152	.0046	10	25	143.3	7027	1.007017	−487	+ 9	−81	1.006458
	L. R.	16 14 00	.....	.0223									
		18 15 20	7280	.0042	9	25½	142.7	7057	1.007048	−487	9	81	1.006489
27	R. L.	15 49 31	.....	.0224									
		17 5 40	4569	.0070	12	16	142.8	7052	1.007040	−486	+11	−77	1.006488
	L. R.	15 47 8	.....	.0233									
		17 8 14	4866	.0068	12	17	143.1	7037	1.007025	486	+11	77	1.006473
29	R. L.	13 45 41	.....	.0236									
		15 6 50	4869	.0065	12	17	143.2	7032	1.007020	−495	+ 5	−61	1.006469
	L. R.	13 47 56	.....	.0225									
		15 4 16	4580	.0067	12	16	143.1	7037	1.007025	495	5	61	1.006474

KNIVES INTERCHANGED, KNIFE 3–4.

May 30	R. L.	13 58 49	.....	.0219									
		15 15 23	4594	.0063	11	16	143.6	7013	1.007002	−498	+10	−64	1.006450
	L. R.	13 56 15	.....	.0230									
		15 17 22	4867	.0061	12	17	143.1	7037	1.007025	498	10	64	1.006473
31	R. L.	17 25 48	.....	.0220									
		18 51 47	5159	.0058	10	18	143.3	7027	1.007017	−491	+ 0	−77	1.006456
	L. R.	17 23 22	.....	.0232									
		18 53 51	5429	.0057	11	19	142.9	7047	1.007036	491	9	−77	1.006477